Appendix D

SVWD Groundwater Management Plan

Scotts Valley Water District
Scotts Valley, California

SCOTTS VALLEY
GROUNDWATER MANAGEMENT PLAN
(AB 3030)

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EXECUTIVE SUMMARY

The Scotts Valley Water District (SVWD) holds the primary responsibility for the management and supply of water to the Scotts Valley area of Santa Cruz County. In recognition of this responsibility, SVWD has directed a Water Resource Management Plan since 1983. On January 1, 1993, California Assembly Bill 3030 (AB 3030) was codified into law. This law encourages local water agencies to manage groundwater resources within their jurisdictions and outlines guidelines for a groundwater management plan. In accordance with these guidelines, SVWD held a public hearing on September 9, 1993 to declare their intention to develop a groundwater management plan.

This report outlines the proposed Groundwater Management Plan for SVWD, and addresses two major areas of concern in Scotts Valley: (1) management of groundwater supplies to meet present and future demands, and to provide for downstream water rights and instream uses; and (2) protection of water quality and remediation of existing groundwater contamination. The report also includes a brief discussion of the hydrogeology of Scotts Valley. Major conclusions and recommendations are presented. If this report is adopted in accordance with the AB 3030 law as the Groundwater Management Plan for Scotts Valley Water District, the conclusions and recommendations would serve as guidelines for groundwater management by SVWD.

Major findings and recommendations of the report are summarized briefly in the paragraphs below, followed by a complete listing of the Conclusions and Recommendations.

Hydrogeology

The hydrogeologic investigations have revealed that the areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited. In such a situation, effective groundwater basin management must be based on extensive groundwater exploration and comprehensive but detailed hydrogeologic investigations. Accordingly, the Groundwater Management Plan recommends that groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with the neighboring San Lorenzo Valley Water District (SLVWD) and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

Groundwater Supply

The groundwater supply section includes a summary of the current groundwater supply status of the basin. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and locally decreased groundwater quality. Along with groundwater level declines, groundwater storage in the developed portion of the basin declined between April 1986 and April 1994 by an estimated 550 to 600 acre-feet per year (AFY), or about 10 percent of estimated total groundwater storage. Although the recent 1992-1993 season was wet, it resulted only in a moderation of the extent and severity of localized groundwater level declines. However, the major natural drain for the basin, Bean Creek, responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

The report also updates groundwater production in the basin. About 70 percent of the total groundwater production is metered, while the remainder had to be estimated, including groundwater production by landscape irrigators, private water purveyors, commercial and industrial firms, and domestic users. The total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks. The perennial yield for the Scotts Valley groundwater basin had been estimated previously to be 4,200 AFY. Accordingly, estimated groundwater production amounts to over 80 percent of the estimated perennial yield. In addition, the preponderance of pumpage is concentrated in a small portion of the groundwater basin.

In response to concerns over the long-term groundwater supply, the report evaluates current groundwater basin management and makes recommendations for future action. The report summarizes the SVWD monitoring program, finding it to be comprehensive, with an appropriate focus on the developed portions of the basin. In addition, the existing Santa Margarita groundwater basin computer model is evaluated. Although requiring periodic updating and refinement, the model can be used to observe effects of proposed well locations and pumping configurations, and potential recharge projects, consequently aiding in groundwater management. In addition, the model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

The Groundwater Management Plan notes that the current estimate of perennial yield is an annual average value. Given the variability of rainfall and recharge in recent years, the perennial yield should be evaluated to provide more specific information on the effect of varied rainfall on groundwater recharge. Recommendations also are provided for more accurate evaluation of basin-wide groundwater storage in light of increased knowledge of the hydrogeology of the area.

The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. Accordingly, SVWD efforts should be supplemented by actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each. More than one such project would be needed to mitigate the current groundwater level declines, and additional conservation, management, and replenishment efforts would be required for any additional increase in local water demands. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated with SLVWD, Santa Cruz County, and major groundwater producers. Accordingly, roundtable meetings are recommended for the major groundwater producers in Scotts Valley to discuss and coordinate means to mitigate groundwater level decline problems. The report also recommends continued efforts toward water conservation and wastewater reclamation and reuse.

Groundwater Quality

The portion of the report addressing groundwater quality presents the regulatory framework for the identification and remediation of contamination problems, discusses existing contamination, and reviews groundwater contamination prevention programs. Recommendations are presented for specific action by SVWD and for cooperation with other agencies.

In brief, the agencies with regulatory responsibility for groundwater contamination in Scotts Valley are the United States Environmental Protection Agency (USEPA), the Department of Toxic Substance Control of the California Environmental Protection Agency (Cal-EPA), Regional Water Quality Control Board (RWQCB), and Scotts Valley Fire Protection District. SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of water satisfying state and federal drinking water standards. In addition, it holds responsibility for enforcement of standards for construction, abandonment, and destruction of water supply wells.

Areas of known groundwater contamination are described briefly in the report, including the benzene plume in the Camp Evers area, three problems in the El Pueblo Road area, and the Watkins-Johnson plume. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible sources. Cal-EPA is the lead agency overseeing the investigation and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the trichloroethene (TCE) and chlorobenzene problems. Of seven possible sources, one site has been identified as a possible source of TCE contamination. A remedial investigation and feasibility study for the site has been prepared, while a remedial action plan remains to be drafted and approved. The USEPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

The existence of potential sources of groundwater contamination in Scotts Valley are identified, including 64 facilities using hazardous materials and 37 active underground storage tanks (USTs), of which 22 are double-walled and meet new tank standards. Septic tanks also are potential sources of contamination.

Given the existence of contamination and the susceptibility of local aquifers to contamination, the report also reviews means to prevent groundwater contamination problems. These include well construction, abandonment, and destruction; hazardous materials management; regulation of underground storage tanks; sewering of areas dependent on septic tanks; and city planning and zoning. In terms of standards for well construction, abandonment, and destruction, SVWD is encouraged to strengthen its enforcement of standards. This would involve updating the well inventory database, tracking the status of wells within SVWD, establishing a notification system to alert private groundwater users of contamination problems, and implementing well construction standards to prevent cross-contamination of aquifers.

In accordance with its responsibility to provide water satisfying state and federal drinking water standards, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination. SVWD also should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

The report notes that no single agency has a regional outlook on groundwater contamination. Given SVWD's existing role in monitoring and managing local water resources and its key role in providing safe drinking water, SVWD can help provide such a regional overview, through cooperation with the regulatory agencies and information sharing.

Conclusions

Hydrogeology

1. The areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited.

2. Much valuable information is available on the hydrogeology of the margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

Groundwater Supply

3. The water resource monitoring program is comprehensive, with an appropriate focus on the developed portions of the basin.

4. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and a somewhat lower groundwater quality.

5. The wet 1992-1993 season resulted only in a moderation of the extent and severity of localized groundwater level declines.

6. Although affected by recent drought, Bean Creek responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

7. Perennial yield for the Scotts Valley groundwater basin has been estimated to be 4,200 AFY. This is an annual average value and is relevant to the area of the Scotts Valley groundwater basin.

8. Groundwater storage in the developed portion of the basin has declined between April 1986 and April 1994 by an estimated 550 to 600 AFY, or about 10 percent of estimated total groundwater storage.

9. The Santa Margarita groundwater basin computer model can be used to observe effects of proposed well locations and pumping configurations, consequently aiding in optimization of the distribution of pumping.

10. The model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

11. About 70 percent of the total estimated groundwater production is metered by SVWD, SLVWD, Watkins-Johnson, and the Mount Hermon Association. Groundwater production was estimated for other groundwater users, including landscape irrigators, private water purveyors, commercial and industrial firms, and domestic users.

12. Total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks.

13. The estimated total groundwater pumpage amounts to over 80 percent of the estimated 4,200 AFY of perennial yield for the Scotts Valley groundwater basin, and is concentrated in the southeast one-quarter of the groundwater basin.

14. The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. SVWD efforts should be supplemented by actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs.

15. More than one replenishment program will be needed to mitigate localized groundwater level declines and to ensure long-term groundwater supply.

16. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each.

Groundwater Quality

17. The Scotts Valley Fire Protection District oversees the City of Scotts Valley's hazardous materials management program, implements state regulations of underground storage tanks, oversees monitoring and soil boring installation and destruction, and responds first to a hazardous material release.

18. The RWQCB regulates sites where groundwater contamination occurs from underground tanks or other sources.

19. The Cal-EPA oversees groundwater contamination sites where the potentially responsible party is not known or is not financially solvent.

20. The USEPA oversees sites that are on or proposed for the Superfund list.

21. SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of

water satisfying state and federal drinking water standards.

22. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible sources.

23. Cal-EPA is the lead agency overseeing the characterization and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the TCE and chlorobenzene problems. Of seven possible sources, Scotts Valley Circuits has been identified as a possible source of TCE contamination. A remedial investigation and feasibility study for the site has been prepared; a remedial action plan remains to be drafted and approved.

24. The USEPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

25. Prevention of groundwater contamination in Scotts Valley is important because of the susceptibility of aquifers to contamination, difficulty in determining sources of contamination, extended time and high costs to remediate contamination, and added costs of wellhead treatment by water purveyors.

26. Improperly constructed or abandoned wells can provide conduits for downward migration of contaminants from the ground surface.

27. SVWD and Santa Cruz County share responsibility for enforcing standards for permitting, construction, abandonment, and destruction of water supply wells.

28. Sixty-four facilities using hazardous materials exist in Scotts Valley, located mostly along Scotts Valley Drive.

29. Thirty-seven active underground storage tanks have been identified in Scott Valley, of which 22 are double-walled and meet new tank standards.

30. Septic tanks represent other potential sources of contamination.

Recommendations

Hydrogeology

1. Groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

Groundwater Supply

2. SVWD should continue data compilation on wells and geology and the program of climatic, surface water, and groundwater monitoring with annual reporting.

3. Groundwater level monitoring by all agencies should be coordinated so that the quarterly measurements occur within a small time period, such as one week.

4. SVWD in cooperation with other agencies should expand data compilation and monitoring as groundwater exploration and production are extended into new areas, or as needed for groundwater replenishment projects or for groundwater contamination investigations or remediation.

5. The perennial yield and groundwater storage of the Scotts Valley groundwater basin should be reevaluated in greater detail.

6. The computer model should be maintained, but revised as additional hydrogeologic data become available.

7. Information on wells and metered groundwater production should be compiled and updated regularly. Groundwater production by large groundwater users should be measured.

8. Following metering of major groundwater producers, consumptive use of groundwater should be analyzed.

9. SVWD should continue its efforts to redistribute its pumpage throughout its service area.

10. Roundtable meetings should be convened by the major groundwater producers to discuss means to analyze and mitigate groundwater level declines.

11. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

12. The conceptual replenishment projects, in addition to others that may be suggested, should be considered in greater depth.Additional investigations would include field work, computer modeling, cost/benefit analysis, and assessment of environmental impacts.

13. SVWD, SLVWD, and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.

14. SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

Groundwater Quality

In order to aid in groundwater contamination prevention, SVWD should strengthen its enforcement of standards for construction, abandonment, and destruction of water supply wells, including the following:

15. Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.

16. Conduct a survey to document the status of wells within SVWD boundaries, and to identify both active and destroyed wells.

17. Once the well survey is complete, establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

18. Given the existence of multiple aquifer systems within SVWD, implement well construction standards to prevent cross-contamination of aquifers.

19. Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.

20. Establish a program to identify and encourage the proper destruction of abandoned wells within SVWD.

21. In accordance with its responsibility to provide water satisfying state and federal drinking water standards, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination, and should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

Overall, SVWD should encourage and cooperate fully with responsible agencies in the investigation and remediation of contamination sites, identification of potentially responsible parties, and prevention of groundwater contamination. SVWD also can provide a regional groundwater management overview and can aid in information sharing among agencies. Accordingly, SVWD and other agencies should:

Hazardous Materials Management

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Institute stricter regulations for sites which use hazardous materials.

Underground Storage Tanks

- Develop more stringent local standard for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

Septic Tank Disposal Systems

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system.
- Encourage hookup of all businesses and residences not currently connected to the sanitary sewer system.

City Planning and Zoning

- Limit future industrial and commercial service development to existing areas.
- Encourage consideration by City planners of groundwater protection issues in land use planning.

Section 1

INTRODUCTION

1.1 Background

The Scotts Valley Water District (SVWD) is a public agency responsible for management and supply of water to the Scotts Valley area. The SVWD service areas includes most of the City of Scotts Valley and some areas outside the city limits (Figures 1 and 2). The City of Scotts Valley is situated in the Santa Cruz Mountains along Highway 17 in Santa Cruz County, north of the City of Santa Cruz, California.

The Scotts Valley area is underlain by the Santa Margarita groundwater basin which was designated as a sole source aquifer by the U.S. Environmental Protection Agency (USEPA) in 1982. This means that the City of Scotts Valley and nearby communities use this aquifer as their sole or principal water supply. Therefore, it is deserving of special protection.

Extensive work toward groundwater management of the Scotts Valley groundwater basin (California Department of Water Resources, 1975) already has been accomplished. SVWD has directed a Water Resource Management Plan since 1983 (Todd Engineers, 1984-1994). In addition, a computer model of the basin was recently developed for a groundwater management study initiated by the Association of Monterey Bay Area Governments (Watkins-Johnson Environmental, Inc., September 1993). The adjacent San Lorenzo Valley Water District (SLVWD) also has conducted a program of groundwater monitoring and specific studies for its portion of the groundwater basin.

Assembly Bill 3030 (AB 3030), codified into law on January 1, 1993, permits local agencies to adopt significant programs to manage groundwater. The purpose of AB 3030 is to "encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions". Accordingly the bill outlines a procedure to develop a groundwater management plan for any local public agency that provides water service to all or a portion of its service area. In accordance with guidelines for the development of a groundwater management plan, a public hearing was held by SVWD on September 9, 1993 to declare their intention to develop a groundwater management plan.

1.2 Purpose

The purpose of this groundwater management plan is to address two major areas of concern in Scotts Valley: (1) management of groundwater supplies to meet present and future demands, and to provide for downstream water rights and instream uses; and (2) protection of water quality and remediation of existing groundwater contamination. By implementation of a groundwater management plan for Scotts Valley, SVWD hopes to preserve and enhance the groundwater resource in terms of quality and quantity, and to minimize the cost of management by coordination of efforts among agencies.

1.3 Scope

The area served by SVWD is the focus of this study. However, it is necessary in some cases to extend the field of study to areas surrounding SVWD boundaries in order to provide a meaningful discussion of hydrogeologic processes and to support basin management planning strategies. Three differing study areas are depicted on Figure 1. The shaded area is within SVWD boundaries while the dotted line outlines the study area defined for the Water Resources Management Plan, which includes hydrogeologically significant regions. The third area is the area encompassed in a groundwater flow model developed for the Santa Margarita basin (Watkins-Johnson Environmental, Inc., September 1993).

This groundwater management plan begins with a brief review of the current understanding of hydrogeologic conditions encountered in the Santa Margarita basin. These hydrogeologic processes influence groundwater recharge and flow patterns, and the potential for groundwater contamination. The plan then proceeds to focus on the management of groundwater supply and groundwater quality.

The groundwater supply section begins by evaluating the monitoring programs in the Water Resources Management Plan. Following this is a description of groundwater level trends and subsequent storage volumes in the Santa Margarita basin. The application and uses of the Santa Margarita groundwater basin flow model for simulating future scenarios is discussed. A section on groundwater replenishment discusses various options for direct or in-lieu groundwater recharge.

The discussion of groundwater quality focusses on: (1) documenting existing groundwater contamination and the status of remediation, and (2) prevention of groundwater contamination in the future. Several items are discussed under the topic of prevention including: hazardous materials management program, underground storage tank programs, well construction and destruction standards, septic systems, and city planning and zoning.

Finally, the conclusions reached in the study are presented. Recommendations for improved management of groundwater supply and quality are suggested.

1.4 Acknowledgements

A number of agencies have been helpful in providing information for this report including: the Scotts Valley Water District, the City of Scotts Valley City Hall, the Scotts Valley Department of Public Works, the Scotts Valley Fire Protection District, The Scotts Valley Building Department, the Santa Cruz County Health Department, the California Regional Water Quality Control Board, the State Water Resources Control Board, the State Department of Water Resources, the California Environmental Protection Agency Toxic Substances Control Division, and the U.S. Environmental Protection Agency.

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Section 2

HYDROGEOLOGY OF SCOTTS VALLEY

2.1 Geologic Units and Structure

A detailed geologic cross-section has been prepared trending northeast-southwest through the most developed portion of Scotts Valley (see Figure 3). This cross-section shows seven major geologic units (Figure 4). The oldest unit consists of pre-Tertiary age granite that underlies Tertiary sedimentary units and Quaternary alluvium in the region. The Lompico sandstone is a major unit in the area with thicknesses of up to several hundred feet. The Monterey shale overlies the Lompico and consists primarily of shale with sandstone interbeds in the lower portion. As shown on Figure 4, the thickness of the Monterey shale varies from locally absent or very thin (less than 20 feet) to as much as 600 feet. This variation is due to structural folding and faulting and erosion of the Monterey shale, resulting in a surface with considerable relief.

The Santa Margarita sandstone was deposited subsequently on top of the irregular Monterey shale surface. As a result, the Santa Margarita tends to thin markedly and locally pinch out in areas where the underlying granite or shale forms a relative "high". The thickness of Santa Margarita ranges up to 350 feet. Overlying the Santa Margarita in some areas is the Santa Cruz mudstone. Deposits of Quaternary alluvium are present in the major valleys.

The major geologic structure in the area is Scotts Valley syncline, a gentle geologic downwarp that extends from Boulder Creek eastward through Scotts Valley. The syncline is characterized by gently dipping beds (0 to 6 degrees) on the south limb of the syncline and slightly steeper dips (0 to 20 degrees) on the northern limb. In the Scotts Valley area, the syncline becomes increasingly deep, and apparently flattens out to the east.

The location of the syncline is shown on Figure 3. In addition, the syncline is portrayed on Figure 4 as the downwarped geologic layers. As indicated, this downwarping has resulted in accumulation and preservation of the thickest part of the geologic formations along the synclinal axis with thinning along the limbs of the fold. This is particularly noticeable for the Monterey shale. Gentle folding in the overlying Santa Cruz mudstone indicates continued downwarping.

As indicated on Figure 4, the Scotts Valley syncline in this area is apparently broken by the two unnamed faults, which occur on either side of the syncline. The down-thrown side of each fault is located towards the synclinal axis, resulting in a down-thrown block. In addition, a second faulted and down-thrown block is apparent in the Camp Evers area. These faults significantly influence the thickness of the Monterey shale and depth to the Lompico sandstone. As shown, the down-thrown blocks are characterized by the thickest Monterey shale and the greatest depth to the Lompico sandstone. The up-thrown blocks are characterized by more extensively eroded and thinner Monterey shale and shallower depths to the Lompico sandstone.

2.2 Hydrogeology

In essence, the Scotts Valley groundwater basin is like a bowl or bathtub, rimmed by granitic rocks and filled with sandstone and shale layers which contain groundwater. The two major aquifers in Scotts Valley are the Santa Margarita sandstone and the Lompico sandstone. Local groundwater exhibits unconfined conditions in the Santa Margarita aquifer, and semiconfined to confined conditions in the underlying Lompico sandstone. The two major aquifers are generally separated from each other by varying thicknesses of the Monterey shale. However, locally the Monterey shale is absent and the two sandstone units are not separated.

The Santa Margarita sandstone receives recharge from rainfall and streamflow where it crops out at the surface, plus subsurface inflow from overlying formations. The Monterey and Lompico formations are recharged at outcrops in northern portions of the basin, and also receive groundwater from overlying units.

According to groundwater level and flow maps, groundwater flow generally is from recharge areas toward Bean Creek, which serves as the basin's outlet. Available data suggest no other significant outlets except pumping wells, which have substantially altered local groundwater flow patterns. Carbonera Creek does not intersect the water table, and water table contours do not suggest subsurface outflow through the granitic rocks.

In recent years considerable hydrogeologic exploration and assessment has been accomplished by SVWD, SLVWD, and private groundwater users. As a result, much valuable information now is available on the hydrogeology of the southeastern, southwestern, and western margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

The hydrogeologic investigations have revealed that the areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited. In such a situation, effective groundwater basin management must be based on extensive groundwater exploration and comprehensive but detailed hydrogeologic investigations. In the future, groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

Section 3

GROUNDWATER SUPPLY

3.1 Current Monitoring Programs

Todd (1980) defines a monitoring program as a scientifically designed surveillance system of continuing measurements, observations, and evaluations. As part of the Scotts Valley Water Resources Management Plan, SVWD maintains a comprehensive monitoring program to protect the long-term supply and quality of groundwater. Results of these monitoring programs are analyzed and presented in annual reports (Todd Engineers, 1984-1994). The current program includes collection of groundwater level data from over 40 wells and collection of water quality and pumpage data from SVWD wells. In addition, there are three streamflow gages, five rainfall gages, and one evaporation measurement station. Drillers logs of wells have been compiled for most of the Scotts Valley and surrounding area with over 400 wells identified and located on a base map. Locations of notable monitoring sites are depicted on Figure 5 while Table 1 is a summary of current Scotts Valley monitoring programs. These programs are described briefly below.

Precipitation. Precipitation is recorded automatically at least every 15 minutes at the El Pueblo Yard and at the City of Scotts Valley wastewater treatment plant (WWTP). The El Pueblo Yard gage has been in operation since 1985. Previously, a bucket gage was in operation at the El Pueblo facility between 1981 and

TABLE 1
SUMMARY OF SCOTTS VALLEY MONITORING PROGRAMS

MONITORING TYPE	LOCATION	MEASUREMENT TYPE	DATE STARTED	FREQUENCY/ MAINTAINER	HISTORIC MONITORING
PRECIPITATION	El Pueblo Yard	15-minute recording	Feb. 1985	Daily/District, Monthly/City	OTHER HISTORIC GAGES: 1) Blair site on Granite Ck. Rd. (Jan. 1975-Dec. 1980) 2) Hacienda Dr. (Jul. 1974-Mar. 1979) 3) El Pueblo Yard bucket gage (Jan. 1981-Jan. 1985)
	WWTP	5-minute recording	1990	Daily/City	
	Kaiser Sand and Gravel Co.	Bucket	Mar. 1985	Varies/Kaiser	
	Carbonera Ck. headwaters @ Scoppetone property	Bucket	Apr. 1985	Varies/Scoppetone	
	Near Lockhart Gulch @ Fabrin's Circle K	Bucket	Mar. 1985	Varies/G.W. Fabrin	
EVAPORATION	El Pueblo Yard	Pan	Jan. 1986	Daily/District	Evaporation pan raw data not compiled after Jul 1990
STREAMFLOW	Carbonera Ck. at Scotts Valley @ Carbonera Way Bridge (#11161300)	15-minute recording	Jan. 1985	Daily/USGS	OTHER HISTORIC GAGES: 1) Carbonera Ck. @ Santa Cruz (#11161400) 250 feet upstream from mouth (1974-1976 partial data) 2) Bean Ck. near Felton (#11160320) (1973-1978 partial data), low flows at same location (1983-1988)
	Carbonera Ck. @ Glen Canyon	5-minute recording	1990	Monthly/City	
	Bean Ck. near Scotts Valley @ Mt. Hermon Crossing (#11160430)	15-minute recording	Dec. 1988	Daily/USGS	
WELL INVENTORY	T10/R01 Sections 6-9, 16-20, 30 and T10/R02 Sections 1, 11-14, 23-26, 36	Over 400 wells: location, log, type, capacity, etc.	1950's	Logs from California DWR and others	-
GROUNDWATER LEVELS	~41 Santa Margarita aquifer and ~7 Lompico formation wells	Depth to water	1968	At least quarterly/ District and others	Data from over 75 wells, as early as 1968, bi-monthly 1983-1989
PUMPAGE	District wells in production and on standby	Metered, compiled monthly	1975	Monthly/District	Additional pumpage from other wells
GROUNDWATER QUALITY	District wells in production and on standby	Title 22 constituents	1963	At least semi-annually/ District and others	Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program
WASTEWATER OUTFLOWS	City of Scotts Valley WWTP @ Lundy Lane	Wastewater outflow volume and effluent quality	1965	Daily/City	Plant operational in 1965 (Septic systems pre-1965)

REF: Todd Engineers (1993)
Todd Engineers (1989)
Todd Engineers (1988)
Handwritten monitoring notes from SVWD on El Pueblo evaporation pan and Kaiser, Scoppetone, and Fabrin rain gages
Water Quality data sheets from various laboratories

1985. Before 1981, rainfall was measured at the Blair site on Granite Creek Road and along Hacienda Drive. The WWTP gage has been in operation since 1990. The rain gages at the El Pueblo Yard and WWTP are also read manually once a day by SVWD or City of Scotts Valley staff, respectively. Manually read data are kept on file at the yard or WWTP, while electronic data are sent to the local consulting firm of Linsley, Kraeger Associates. Data have not been compiled since 1993 due to lack of funding.

In addition, three bucket rain gages have been maintained since 1985 at the Kaiser Sand and Gravel site (Kaiser), on the Scoppetone property near the headwaters of Carbonera Creek, and at the Fabrin's Circle K Ranch near Lockhart Gulch.

Evaporation. An evaporation pan has been maintained at the El Pueblo Yard since 1986. Current data have not been compiled into useable form because of lack of funding.

Streamflow. Two streamgages are monitored in cooperation with the United States Geological Survey (USGS); SVWD provides the funding for gage installation and maintenance. One gage is located on Carbonera Creek at the Carbonera Way Bridge (USGS #11161300) and was installed in early 1985. It has a punch paper tape and records water levels every 15 minutes. The other gage is on Bean Creek at the Mount Hermon crossing (USGS #11160430) and has been in operation since late 1988.

A third gage is located on Carbonera Creek at Glen Canyon. Data for this third gage are recorded every 5 minutes and manually read once a month by City of Scotts Valley staff. Data recorded at this gage has not been compiled because of lack of funding.

Well Inventory. Over 400 water well drillers' reports have been compiled from the California Department of Water Resources (DWR) and other sources. These wells are located throughout the Scotts Valley area. Compiled well data include location, well log, well use, capacity, depth, and ground surface elevation. It should be noted that these wells include all those drilled historically, many of which are now unused.

Groundwater Levels. The groundwater level monitoring program has included SVWD wells, SLVWD wells, other municipal wells, monitoring wells, and private wells. Between 1983 and 1989 groundwater levels were measured every two months. In 1989 it was determined that static groundwater levels and regional flow patterns did not change significantly over a two-month period, and that measurements of water levels on a quarterly basis would be sufficient. Consequently, water level measurements are taken on or about the first day of January, April, July, and October. Data are compiled into computer databases by Todd Engineers and made available to SVWD.

Water level contour maps are prepared for autumn and spring conditions for the regional Santa Margarita aquifer and for the

Lompico Formation; spring maps are presented in annual reports. Wells used to produce the Santa Margarita aquifer and the Lompico Formation water level contour maps are shown on Figure 5.

Pumpage. Pumpage is recorded daily for operating SVWD wells, and compiled on a monthly basis for management purposes. Available pumpage information from SLVWD is also compiled.

Groundwater Quality. Currently, groundwater quality samples are collected from SVWD wells in production and on standby as shown on Figure 5. These pumping wells are generally sampled semi-annually or more frequently if constituents of concern are detected.

Historically, analyses from over 80 wells are available in the database. Selected sites were originally sampled bi-monthly and analyzed for nitrate, chloride, and total dissolved solids (TDS). Due to the slow rate of change typical of groundwater quality and lack of significant regional trends, this program was revised in 1989 to focus on SVWD wells. Groundwater is sampled for the constituents required by Title 22, California Administrative Code, Chapter 15. Analyses include: general mineral, physical, inorganic, radiological, bacteriological, and regulated and unregulated organics. Since 1982 groundwater from the SVWD wells has also been analyzed for volatile organic compounds (VOCs).

Wastewater Outflows. Data are available from the City of Scotts Valley on wastewater outflow volumes and effluent quality; monthly flow data are compiled.

Recommendations

- The groundwater level and quality monitoring network is comprehensive and provides good areal coverage of Camp Evers and Scotts Valley. Accordingly it should be continued. Monitoring sites are relatively few and far between in the northern half of the study area and along the eastern margin; however, additional test or monitoring wells are planned for the latter area (see Figure 5).
- The quarterly groundwater level measurements should be coordinated so that they are conducted within a small time period, such as a week.
- Monitoring programs should be flexible and open to supplementary frequency and locations to document or understand site specific occurrences such as recharge rates or potential groundwater contamination.
- Data sharing with other agencies should continue and improve, and the processing of rainfall, evaporation, and streamflow data should be encouraged.

3.2 Groundwater Level Trends

Figure 6 depicts water level trends (hydrographs) for select wells in the vicinity of SVWD. The wells depicted on the figure are El Pueblo Well 7, Businessmen's Well 10, monitoring Well 13, Well 7A, and the Estrella well which is not within SVWD boundaries. Seasonal fluctuations can be seen in these curves, with higher water levels in late winter and spring and lower levels in summer and fall. It is apparent from the figure that water levels have been steadily declining since the mid-1980's. The sharpest decline has occurred in Businessmen's Well 10 in the Camp Evers area, where levels have dropped over 150 feet between 1985 and 1993. Water levels have been recovering in this well since January 1994 because pumpage has been shifted to other SVWD wells, particularly Well 7A. El Pueblo wellfield and Estrella well water level elevations have both dropped over 100 feet since 1987. These three wells are in developed portions of the basin while monitoring Well 13 (destroyed) and Well 7A are in the less developed northern area. Recent water levels in Well 7A have declined sharply due to a shift of pumpage from the developed areas (Camp Evers area) to Well 7A.

A bar graph on the bottom of Figure 6 indicates the monthly Scotts Valley rainfall measured at the El Pueblo Yard. Comparison of the bar graph with the water level hydrographs demonstrates that periods of high rainfall cause water levels to rise while, conversely, periods of low rainfall or drought result in declining water levels. Clearly, the drought that occurred from the mid-1980's to the early 1990's contributed to the declining water levels due to less recharge and increased pumpage. However, the 1992-1993 rainfall season was marked by rainfall of 50 inches or

125 percent of average. Although this rainfall resulted in seasonal recovery of water levels in wells, the longer term effect was only a moderation of the extent and severity of the area's localized water level declines. This indicates that in the past decade the predominant factor in groundwater levels in the Camp Evers and Scotts Valley Drive areas is groundwater pumpage and not recharge.

As documented in the 1993-1994 Water Resources Management Plan (Todd Engineers, June 1994), baseflows of Bean Creek showed a noticeable response to the increased rainfall of the 1992-1993 season, despite the continued groundwater level declines in the Camp Evers area. This suggests that the baseflow (as measured at the Mount Hermon crossing) is maintained primarily by groundwater inflow from the northern part of the basin. In the short term, the intensive pumpage in the Camp Evers area has resulted primarily in localized groundwater storage depletion and not in depletion of stream baseflows.

Increased pumpage, reduction of recharge, and drought conditions have resulted in groundwater declines since the mid-1980's and the subsequent repercussions listed below.

- Water levels have dropped below well screens causing some shallow wells to dry up.
- Well screens across upper aquifers (i.e. Santa Margarita aquifer) are exposed when the aquifer locally goes dry.
- Well efficiency decreases due to pumping groundwater from deeper and less permeable aquifers.

- Groundwater quality may decline as a result of extracting water from a deeper aquifer of poorer quality.

Previous reports by Todd Engineers have concluded that despite localized groundwater declines, the groundwater basin as a whole is not in overdraft. This was corroborated by an extensive regional groundwater study, Santa Margarita Ground-Water Basin Management Plan (Watkins-Johnson Environmental, Inc., September 1993). This investigation considered an area of 111 square miles in the San Lorenzo River watershed, focusing on Scotts Valley, and entailed development of a computerized groundwater model of the Santa Margarita, Monterey, and Lompico aquifers. The report states that the groundwater basin is not considered to be in overdraft, and concluded that the safe yield of the basin may be defined as maintenance of flow in Bean Creek. Although streamflows are quite low because of the past drought, the long-term safe yield has not been exceeded.

3.3 Perennial Yield and Groundwater Storage

The perennial yield is defined as the rate at which water can be withdrawn perennially under specified operating conditions without producing an undesired result (Todd, 1980). Perennial yield was estimated at about 4,200 acre-feet per year (AFY) for the area within the dotted line on Figure 1 (Todd Engineers, 1987). The area used for the 4,200 AFY estimate is approximately three times the area within SVWD boundaries. Note that a constraint on available groundwater is the quality of the water and the presence of contaminants in groundwater. Persistent contamination can not only limit the usable storage capacity of the aquifer and circumscribe areas of groundwater development, but also can adversely affect significant recharge areas. It should also be noted that perennial yield was estimated as an average annual value, and does not take into account annual or short-term variations in rainfall. Given the variability of rainfall and recharge in recent years, consideration should be given to a more detailed perennial yield study that would evaluate the effect of varied rainfall on groundwater recharge.

Figure 7 documents change in groundwater levels over the seven years between April 1986 and April 1993. Wells used to prepare the contour map are indicated with a solid black dot with a groundwater level change number by the well. The pattern of groundwater level decline is similar to annual water level declines depicted in Todd Engineers yearly management plan reports, although the magnitudes of the declines are greater. Minimal groundwater level changes have occurred throughout most of the area, with localized declines in the areas where flow converges into major pumping wells in the Scotts Valley Drive/El Pueblo area and Camp Evers area. Groundwater levels changes for the seven year period are on the order of 120 feet in the center of these depressions. Several minor isolated groundwater level changes have occurred outside these major depressions and are indicated but not contoured on the figure.

A storage volume change can be calculated by measuring the volumetric change in groundwater between April 1986 and April 1993. Assuming a storage coefficient of 0.12, the amount of storage depletion was approximately 4,152 acre-feet (AF) or an average of 593 AFY over the seven year period. A loss of 565 AF was calculated for the storage depletion between April 1993 and April 1994 (Todd Engineers, June 1994). Thus, approximately 500 to 600 AF have been lost from groundwater storage each year since the mid-1980's. It should be noted that this change in storage has been computed using a consistent methodology as in previous years. However, estimates of total groundwater storage and change in storage should be revised to take into account increased knowledge of the extent, depth, and storativity of the Lompico aquifer and to take into account the decline in some areas of groundwater levels from the Santa Margarita aquifer into the Lompico aquifer.

Available water stored in the Santa Margarita has been estimated at 43,460 AF (Todd Engineers, 1987). Previously, a slightly larger value was used, but was revised following improved mapping of water levels in the vicinity of the Grace Way monitoring well. Thus, using the groundwater storage depletion number calculated above (4,152 AF), approximately 9.6 percent of the total storage volume has been depleted between April 1986 and April 1993.

3.4 AMBAG Model

A proposed management plan for the Santa Margarita groundwater basin was developed by Watkins-Johnson Environmental, Inc. for the Association of Monterey Bay Area Governments (AMBAG) (Watkins-

Johnson Environmental, Inc., September 1993). The purpose of the plan was to coordinate users of the Santa Margarita groundwater basin, establish groundwater and streamflow resource management, and prevent groundwater pollution.

A major accomplishment of the plan was development of a groundwater flow model for the Santa Margarita basin. This model can be used to study the effects of possible future development and environmental stresses on the groundwater basin. The model area of 24.3 square miles encompasses the Santa Margarita aquifer and major portions of the Monterey and Lompico aquifers as depicted on Figure 1 (Watkins-Johnson Environmental, Inc., July 1993). The model is a modified version of MODFLOW, developed by the USGS and simulates groundwater flow in the three aquifers (three layers). The model was calibrated using 1986 water levels and verified with 1991 data.

Model Simulations. The model was used to study the four simulations listed below.

- 5 years additional drought (60 percent recharge) and 1992 pumping.
- 5 years normal recharge and 1992 pumping.
- 5 years normal recharge, 1992 pumping quantities with a shift of pumpage to Well 7A.
- 25 years drought (80 percent recharge), increased pumpage of wells in simulation above for the estimated population in 2015 (almost 30 percent increase from 1993).

Results of these simulations indicate that pumping and drought conditions have resulted in declining water levels and reduction of stream baseflow. Although the basin is not considered to be in overdraft, declining surface water quantities and future groundwater levels are a concern. The above scenarios also indicated that it would be advantageous to extract future groundwater from the Lompico aquifer rather than the Santa Margarita aquifer. The worst case simulation indicated that surface water flow would be substantially reduced and additional wells would need to be dispersed across the basin to support the estimated 2015 population due to a greater area of the Santa Margarita aquifer going dry.

Limitations. The MODFLOW program is widely used and accepted, and has been applied to the Santa Margarita basin with diligent regard for the considerable complexity of the groundwater basin. However, a model can only reflect data available at the time it was written. For example, the eastern boundary of the model was simulated as a groundwater divide between the Santa Margarita and Soquel-Aptos groundwater basins. However, the Lompico aquifer extends into the Soquel-Aptos basin in the area of Blackburn Gulch. To properly simulate the pumping of new wells in this area it may be necessary to revise the model by extending it to the east or changing the boundary conditions to reflect the possible influence of the adjoining groundwater basin.

General model limitations are listed in the Santa Margarita Groundwater Basin Management Plan report (Watkins-Johnson

Environmental, Inc., September 1993). These limitations include the problems inherent in the simplification, interpretation, and limited availability of field data. For instance, a single transmissivity value was used for the Lompico aquifer and a few average values of transmissivity were used for the Monterey aquifer. Future, more detailed transmissivity data could be incorporated into the model in the future, although the model would need to be recalibrated at that time.

Recent Simulations. Pre- and post-processor programs (MODEDIT and MODPOST) allow some modification of the program data packages, such as model timing for transient simulations, well locations and pumping rates, recharge rates, and solution criteria (i.e. how refined the solution will be). For example, the model can be used to simulate the effect of new wells or changing pumping rates of existing wells, various droughts, and/or changes in recharge.

Todd Engineers modified the program to run the four preliminary scenarios listed below.

- 6 years drought (60 percent recharge) and 1992 pumping.
- Same as above with one additional year of drought at 80 percent recharge.
- 5 years drought (80 percent recharge), drought pumping, 1986 starting heads, and Well 7A pumping at 32,000 cubic feet per day (ft^3/d).
- Same as above with estimated Lompico fault location simulated as a barrier.

Preliminary results indicate that the pumping of Well 7A at 32,000 ft^3/d (500 gallons per minute for 8 hours per day) did not appreciably increase drawdowns, although it is near the eastern edge of the model. Insufficient hydrogeologic data exist for this boundary; therefore the accuracy of the model response to pumping in this area is questionable. The simulated Lompico fault caused water levels to deepen on the southeast side of the fault resulting in greater groundwater drawdowns in the El Pueblo area.

In summation, the model can be used to observe effects of proposed well locations and pumping configurations, consequently aiding in optimization of the distribution of pumping. The model also would be useful in regional assessment of proposed replenishment or recharge projects. The AMBAG model is not designed for contaminant transport; nonetheless a program called MT3D, developed by S.S. Papadopulos & Associates, Inc. can be used to model migration of dissolved substances in groundwater. MT3D utilizes MODFLOW groundwater level output and simulates contaminant transport taking into account advection, dispersion, and chemical reactions. Other codes, such as MODPATH and PATH3D, are designed for three dimensional particle tracking and can use groundwater levels from MODFLOW. These model codes can be used to track a contaminant "particle" back to its source or forward in time to a future position. The usefulness of these programs is limited to the availability and reliability of the hydrogeologic and chemical data for the area of interest.

Recommendations

- When additional hydrogeologic data become available, modifications to the basic model should be made, such as simulation of the presence of a fault in the Lompico formation northwest of the El Pueblo well field.
- Future model revisions should extend the model eastward to more accurately simulate the effects of pumping wells in that area.
- Current production data should be incorporated into the model.

3.5 Pumpage

The localized decline of groundwater levels raises concern about overall groundwater supply and the risk of overdraft. Previous groundwater studies conducted for SVWD have indicated that the groundwater basin is not in overdraft. This conclusion also was reached by the recent Santa Margarita aquifer study sponsored by AMBAG. However, this study rightly noted the need to update the amount of groundwater use. Accordingly, this section summarizes the updated inventory of wells and amount of groundwater production, and discusses groundwater consumption.

Well Inventory. The well inventory has been updated recently, as summarized in the 1994 annual report for the Water Resources Management Plan (Todd Engineers, 1994). This inventory was based largely on water well drillers' reports filed with the DWR. Accordingly, it provides only an approximation of wells currently in use. The actual number of wells could be greater, because water well drillers' reports may not have been filed for all wells. Conversely, the number of wells in use could be smaller, because information on abandonment of wells is lacking.

Review of the database, which includes wells drilled as early as the 1950's, indicates that well drilling activities peaked in the 1970's and have since declined. In the 1970's, well drillers' reports were filed for production wells at rates exceeding 20 per year. During the 1980's and early 1990's, these rates declined to less than 10 per year.

The inventory indicates that over 400 known wells have been drilled in the Scotts Valley groundwater basin in addition to the numerous (over 70) monitor wells drilled at the Watkins-Johnson site. Of the 400, approximately 260 wells have been drilled for domestic purposes. Other use categories include wells drilled for municipal supply, landscape irrigation, industrial and commercial purposes, and groundwater remediation.

Groundwater Pumpage. Actual groundwater production data are available only for SVWD, SLVWD, Mount Hermon water system, and Watkins-Johnson remedial wells. Mount Hermon's groundwater production from both springs and wells amounted to 145 AF in 1993 (R. Jones, personal communication). The remedial pumpage amounts to about 200 AFY (Watkins-Johnson, Environmental, Inc., 1994). Historic groundwater production by the two districts is illustrated on Figure 8.

Data are available for SVWD from 1976 to present; note that groundwater pumpage in 1980 was estimated because of meter failure in that year. SLVWD data currently are being processed into an easily accessible, computerized form; and are available from 1987 to present. As indicated, SVWD groundwater pumpage increased 2.6 times from 537 AFY in 1979 to 1,400 AFY in 1989. However, in recent years, the rate of increase has slowed. In 1993, SVWD groundwater pumpage amounted to 1,505 AF.

SLVWD operates three well fields, including two in the Scotts Valley groundwater basin--the Olympia well field located near Zayante Creek and the southern wells, notably the Pasatiempo wells near Graham Hill Road. The third well field, Quail Hollow, was not considered here. As shown on Figure 8, groundwater pumpage by SLVWD from the Olympia and Pasatiempo wells during the past seven years has been fairly steady, averaging 675 AFY. In water year 1993, SLVWD pumpage was 645 AF, including about 335 AF from Olympia and 310 AF from Pasatiempo.

The remaining groundwater producers do not meter their wells. Accordingly, their pumpage can only be estimated. Previous estimates of pumpage were made for the AMBAG model (Watkins-Johnson Environmental, Inc., September 1993), and by Jacobvitz (1987), Todd Engineers (1987), and Luhdorff & Scalmanini (April 1984).

A significant amount of groundwater is pumped from the Scotts Valley groundwater basin by private well owners for landscaping purposes, including irrigation and maintenance of decorative ponds. Major landscaped areas include Valley Gardens golf course and the landscaped commons of the Montevalle, Spring Lakes, and Vista del Lago residential developments. Of these, only Montevalle is located within SVWD boundaries; the others are located along the southern boundary. Other large landscaped areas, notably the new Borland campus, are supplied with SVWD water. As an indication, meters for the Borland site indicate water use of 38 AF from June 24, 1993 to May 5, 1994, or an estimated annual use of about 45 AF. Estimates of landscaping use for each of the other properties have ranged as high as 196 AFY (Todd Engineers, 1987). Accordingly, a rough estimate of 125 AFY for each of the four major landscapers was assumed, for a total of 500 AFY.

The Scotts Valley groundwater basin is also tapped by a number of privately owned water purveyors, listed below in Table 2 along with their number of connections.

Table 2
Private Water Purveyors

Water System	Number of Connections
Mount Hermon	462
Spring Lakes	223
Vista del Lago	202
Manana Woods	118
Mission Springs	100
Fern Grove Club	69
Hidden Meadows	11
Spring Brook Park	11
Fern Brook	9

As noted previously, water production is metered by Mount Hermon for its 462 connections and conference facility, and amounts to 145 AFY. Groundwater production for the remaining water purveyors was estimated by applying groundwater pumpage factors to the number of connections. Based on the SVWD average groundwater production factor of 0.32 AFY per connection (288 gallons per day per connection), (J. Sansing personal communication), an approximate factor of 0.3 AFY per connection was assumed for most of the private purveyors (Manana Woods, Mission Springs, Fern Grove Club, Hidden Meadows, Spring Brook Park, and Fern Brook). Accordingly, the estimated total groundwater pumpage of these purveyors for their 318 connections is approximately 95 AFY (0.3 AFY per connection x 318 connections).

The Spring Lakes and Vista del Lago developments consist of relatively densely-spaced pre-fabricated homes with minimal individual landscaping. Accordingly, a pumpage factor of 0.15 AFY per connection was assumed, resulting in an estimated groundwater demand of 64 AFY (0.15 AFY per connection x 425 connections). However, in 1993 SLVWD supplied about 47 AF to the two water systems. For simplicity's sake and to avoid double-counting, this amount was assumed to be applied to domestic use. Consequently, groundwater pumpage in 1993 for domestic use by Spring Lakes and Vista del Lago is computed as 17 AF, or about 15 AF. Groundwater pumpage for their landscaped common areas was accounted for in the previous section.

In sum, total groundwater pumpage by the private water purveyors is estimated to be 255 AFY, including 145 AFY for Mount Hermon, 15 AF for Spring Lakes and Vista del Lago (not including landscaping or the SLVWD contribution), and 95 AFY for the remaining purveyors.

The updated well inventory indicates the existence of about 260 domestic wells in the Scotts Valley groundwater basin. It is assumed that most of these wells serve a single household with landscaping. Accordingly, assumption of the groundwater pumpage factor of 0.3 AFY yields a total estimated pumpage of approximately 80 AFY. Little of this pumpage occurs within SVWD boundaries.

Of the local industrial and commercial groundwater users, the largest is Kaiser Sand and Gravel. Previous estimates of Kaiser's groundwater pumpage has ranged from 106 AFY (Jacobvitz, 1987) to 268 AFY (Todd Engineers, 1987), with a more recent estimate of 200 AFY (Watkins-Johnson Environmental, Inc., September 1993). For this study, an approximate pumpage of 200 AFY was assumed for Kaiser.

Other industrial and commercial groundwater pumpers include such disparate businesses as food processing companies, lumber yards, computer-related fabrication plants, and retail stores. With such various activities, groundwater pumpage by each business could range from less than one AFY for a small business using the well for domestic purposes to 40 AFY (Jacobvitz, 1987). Less than 15 current small industrial/commercial well owners are known. Assuming an average groundwater pumpage of 5 AFY, the approximate total pumpage is 75 AFY, most of which occurs within SVWD bounds.

The groundwater pumpage by the Silverking aquaculture enterprise amounts to an additional 66 AFY (Watkins-Johnson, Environmental, Inc., September 1993) However, this pumpage represents essentially a groundwater diversion near the outlet of the basin with minimal consumption. Accordingly, it is not included in the sum of groundwater pumpage.

Groundwater production estimates are summarized in Table 3 and on Figure 9, along with the 1993 pumpage totals for SVWD, SLVWD, Mount Hermon, and Watkins-Johnson remediation. It should noted that this pumpage is summarized for the Scotts Valley groundwater basin, as defined for the Scotts Valley Water Resources Management Plan (see Figure 1). Pumpage occurring within SVWD boundaries amounts to about 1,880 AFY and includes pumpage by SVWD itself, Montevalle landscaping use, Watkins-Johnson remedial pumpage, and most of the other commercial/industrial pumpage.

Table 3
Current Groundwater Pumpage, AFY
Scotts Valley Groundwater Basin

Municipal	
SVWD	1,505
SLVWD	645
Major Landscapers	500
Water Purveyors	255
Domestic	80
Watkins-Johnson Remedial	200
Kaiser Sand & Gravel	200
Other Industrial/Commercial	75
Total Estimated Pumpage	3,460

Summary of Pumpage. Approximately 3,460 AFY of groundwater are currently being pumped from the Scotts Valley groundwater basin. Of this amount, 2,495 AFY or 72 percent is metered by SVWD, SLVWD, Mount Hermon, and Watkins-Johnson. The remainder is estimated and subject to correction. Measurement of production by only six additional groundwater producers (Montevalle, Valley

Gardens, Spring Lakes, Vista del Lago, Manana Woods, and Kaiser) would result in compilation of reliable data for over 90 percent of total pumpage.

This gross pumpage value does not account for return flows. Return flows represent pumped groundwater that is returned to recharge the groundwater basin. They include percolation from landscaping ponds and irrigation, leakage from water supply pipelines, and percolation from septic systems. In addition to return flows, gross pumpage also includes actual groundwater consumption, which results from evaporation and transpiration, wastewater export to the ocean outfall, and possibly through overflow of groundwater-supplied decorative ponds and waterways to streams leaving the groundwater basin. At this time, insufficient data are available to assess return flows and actual groundwater consumption. However, a preliminary review of return flows suggests that consumptive groundwater use probably is on the order of 60 to 70 percent of gross pumpage or 2,000 to 2,800 AFY. Accordingly, groundwater consumption is on the order of 50 to 65 percent of the perennial yield of 4,200 AFY.

The estimated total pumpage of 3,460 AFY amounts to over 80 percent of the estimated perennial yield of 4,200 AFY for the Scotts Valley groundwater basin. Even accounting for return flows, the groundwater pumpage and consumption represents a substantial portion of the perennial yield. As will be discussed in greater detail in later sections, successful maintenance of this groundwater production into the future will require intensive management of the water resources of the entire groundwater basin.

Groundwater pumpage currently is focused on a small portion of the groundwater basin. Pumpage within SVWD boundaries amounts to about 1,900 AFY, including production by SVWD, Montevalle, Watkins-Johnson, and other industrial/commercial firms. In the contiguous areas bounding SVWD on the southwest, an additional 1,100 AFY is pumped by SLVWD, landscape irrigators, water purveyors, and Kaiser. Thus, 3,000 AFY or about 87 percent of the groundwater pumpage is being produced from the southeast one-quarter of the groundwater basin. Not surprisingly, these areas of focused pumpage coincide with localized groundwater level declines.

It should be acknowledged that SVWD has and is making a considerable effort toward redistribution of its pumpage out of the localized areas of groundwater decline. However, the efforts of a single, albeit major, pumper to redistribute pumpage will not be sufficient to mitigate the groundwater level declines. Current SVWD efforts should be supplemented by additional actions of SVWD and other major local groundwater producers to reduce or redistribute pumpage, to minimize groundwater losses from the basin, or to initiate groundwater replenishment programs.

Recommendations

- The well inventory should be maintained and updated periodically.

- Information on pumpage by SVWD and SLVWD should be compiled regularly, with periodic compilation of production data from Mount Hermon and Watkins-Johnson.
- The amount of groundwater production should be measured for the larger groundwater users including Montevalle, Valley Gardens, Spring Lakes, Vista del Lago, Manana Woods, and Kaiser.
- An analysis should be made of return flows and consumptive use of groundwater in the basin.
- SVWD should continue its efforts to redistribute its pumpage throughout its service area to mitigate localized impacts of pumpage.
- Roundtable meetings should be convened by the major groundwater producers in Scotts Valley to discuss various means to analyze and mitigate groundwater level decline problems in the Camp Evers - Lockewood Lane - Mount Hermon area. Such means could include redistribution of pumpage, groundwater replenishment projects, minimization of outflows through the Camp Evers tributary, construction of interties among water systems, determination of operational groundwater levels ("target levels"), and development of joint drought contingency plans.

3.6 Replenishment of Groundwater

SVWD has sponsored or participated in a number of studies involving groundwater replenishment. These have included consideration of treated groundwater, reclaimed wastewater, and local surface water as potential sources for groundwater recharge or irrigation use. No projects have yet been implemented because of regulatory or economic constraints. Nonetheless, groundwater replenishment remains an important management method to mitigate groundwater pumpage impacts and to ensure long-term groundwater supply. Accordingly, this section presents a re-evaluation of previous replenishment studies and an update of the potential for wastewater recycling.

Review of Previous Studies. In the early 1970's treated sewage effluent was being recycled in Scotts Valley for various uses. As part of this wastewater reuse effort, a study was conducted to evaluate percolation rates at Skypark Airport (Lowney, 1973). Nine percolation pits were drilled with a bucket auger rig to depths ranging from 28 to 55 feet. Two percolation tests were conducted and measured percolation rates were 0.67 feet/day for a seven foot deep pit with an average head of 1.3 feet and 13.4 feet/day for a 40 foot deep pit with an average head of 35 feet.

A 1974 study completed by Harding Lawson described the disposal of treated effluent to the Kaiser sand pit and Skypark Airport, and its use for irrigation at Valley Gardens golf course and other sites. At the time, the approximate treatment plant capacity was 100,000 gallons per day (gpd) with plans to expand to 400,000 gpd. The increased flow was to be discharged to Kaiser sand pit. Hydraulic conductivity values estimated for the Santa

Margarita sandstone in the vicinity of Kaiser sand pit ranged from 0.0016 to 0.16 feet/day. The estimated groundwater flow direction was northward from the sand pit towards Bean Creek.

A nitrate pollution study conducted in 1984 described the use of treated wastewater for irrigation at Valley Gardens golf course and discharge to Kaiser sand pit and Skypark (Luhdorff & Scalmanini, September 1984). Regulations adopted by the Regional Water Quality Control Board (RWQCB) in 1976 limited the quantity of wastewater disposal to 400,000 gpd at Kaiser and 80,000 gpd at Skypark. In 1978, the RWQCB adopted an order to stop wastewater disposal at Skypark in 1979 and at Kaiser upon completion of the Santa Cruz outfall in 1981. Average wastewater discharge rates were estimated to be 144,000 to 288,000 gpd for Kaiser sand pit for the period 1974 to 1975. Discharge rates at Skypark were unknown and essentially terminated by 1976. Treated wastewater also was sold to Scotts Valley Intermediate School and the California Department of Transportation for landscaping, and to construction companies for dust control. It was estimated that 12 to 95 AFY of treated wastewater were used for landscape irrigation and construction between 1981 and 1983.

In 1988, SVWD retained Todd Engineers to evaluate water reuse options for the Watkins-Johnson remediation system. Watkins-Johnson was pumping 250 gpm on a continuous basis and discharging most of the treated water to Bean Creek. Five alternatives under consideration for this study were artificial recharge, landscape irrigation, an upgradient injection barrier, a perimeter injection barrier, and reuse at the fish hatchery. Options for artificial recharge included seasonal recharge through SVWD wells, surface recharge in Carbonera Creek channel, and year-round recharge in dedicated wells. Landscape irrigation options included four private organizations in the Camp Evers area, and a planned golf course in the Glenwood area. An evaluation of feasibility, costs, and benefits showed that the best alternative was to combine surface recharge of Carbonera Creek during dry months with recharge through SVWD wells during wet months.

In 1989, SVWD retained Todd Engineers to evaluate water recycling and conservation measures. Artificial recharge was considered from three sources: urban runoff, streamflow, and treated wastewater. The primary concern regarding urban runoff is water quality; therefore, this study proposed to use runoff only from residential and public land uses. It was estimated that 1,160 to 2,150 AFY of runoff was potentially available, although only a portion of this total could realistically be conserved. Streamflow was initially considered from both Bean and Carbonera Creeks. However Bean Creek was subsequently eliminated as a source of water due to high pumping lifts and potential environmental impacts. It was estimated that 4,335 AFY was potentially available from Carbonera Creek, although recharge rates and other factors limit the actual amount that can be retained. The recharge capability of the existing channel was estimated to be 176 AFY, with a potential increase to 312 AFY through construction of check dams. Estimates indicated that off-stream spreading basins could recharge an additional 616 to 1,267 AFY of Carbonera Creek streamflow.

The quantity of treated wastewater available in 1988 was estimated to be 754 AFY. At that time only 100 AFY were being reused for golf course irrigation. Water quality is the primary concern for utilization of treated wastewater in artificial recharge, and its reuse for artificial recharge could require abandonment of water supply wells adjacent to a proposed recharge facility.

Four specific projects were considered in detail in the 1989 study for artificial recharge of surface water and treated wastewater: Whispering Pines, Valley Gardens golf course, Skypark Airport, and Carbonera Creek channel. Whispering Pines appeared to be the best site, and involved shallow spreading basins to obtain 1,750 AFY of recharge with a net wetted area of nine acres. This site has since been developed for commercial purposes. Skypark Airport also appeared to be a good site, with 590 to 980 AFY of water potentially being recharged over a net wetted area of four acres. This recharge estimate for Skypark was based on diversion of Carbonera Creek flows as the primary source water. The Carbonera Creek channel was suggested as another artificial recharge area with good potential. The evaluation of Valley Gardens golf course indicated poor potential for use in artificial recharge.

Todd Engineers conducted a very brief assessment in 1990 of recharge characteristics for a parcel located adjacent to Well 11 on Scotts Valley Drive at El Pueblo Road. This site encompassed an abandoned sand quarry and included approximately five acres of level ground. In addition, a small unnamed channel, draining a watershed of approximately 45 acres, crosses the site and flows into Carbonera Creek. The site is underlain by permeable soils and the Santa Margarita sandstone. Potential recharge projects included check dams in the unnamed channel and percolation in the sand pit.

In 1990, SVWD requested that Todd Engineers evaluate potential artificial recharge basins at Skypark in more detail. Three possible conceptual designs were considered: a seasonal recharge basin, a perennial landscaping pond, and a dedicated recharge basin. The source of water would be local runoff diverted from the adjacent Dufours Tributary. A seasonal recharge basin was envisioned near the center of the site with potential to recharge approximately 120 AFY over a net wetted area of two acres. This seasonal recharge basin could serve as a softball field during the dry season. Alternatively, the basin could serve as a perennial landscaping pond if wet season runoff were supplemented by reclaimed wastewater/surface water during the dry season. A perennial pond would be capable of considerably more recharge than a seasonal facility. The third design involved a two-acre dedicated recharge basin along the eastern property line. Local runoff during the wet season would be supplemented by reclaimed wastewater during the dry season. Conclusions of this study indicated that artificial recharge at Skypark would not directly increase potable groundwater supplies to SVWD wells because of groundwater flow patterns at the time. However, such recharge would mitigate impacts of urbanization on groundwater and Bean Creek streamflow. Furthermore, recharge at this site could help mitigate future increased pumpage in other areas of the basin.

Again in 1991, SVWD retained Todd Engineers to evaluate alternative methods of artificial recharge at Skypark. Other options besides spreading basins included modification of landscaping and infiltration trenches. Preliminary analyses indicated that considerably less recharge would be achieved by landscape modification or infiltration trenches compared to spreading basins. However, spreading basins would require considerably more land for construction.

Current and Future Status of Wastewater Treatment. The Scotts Valley wastewater treatment plant (WWTP) currently meets secondary discharge requirements. The treatment process includes organics removal, aeration/oxidation, and disinfection. Effluent from the plant is presently piped to Santa Cruz for discharge to the ocean. The average effluent volume is approximately 0.8 million gallons per day (mgd). The flow process includes an influent pumping station, aeration tank, secondary clarifier, and chlorine contact tank.

Future plans for the wastewater treatment plant would increase capacity to 1.5 mgd. In addition, expansion plans will upgrade the treatment process to meet secondary reclamation requirements. The treatment process would include additional disinfection needed for wastewater recycling (S. Hamby, personal communication). This water could be reused for construction activities, irrigation, or blended for surface recharge basins (up to 20 percent of total source water). Facilities to be added or expanded upon include a new influent pumping station with mechanical barscreens, a new flow equalization structure, an additional secondary clarifier, modifications to the aeration tank, expansion of the chlorine contact tank, and expansion of the laboratory and buildings.

Additional funding is currently being pursued to add facilities necessary to achieve tertiary treatment standards. AMBAG is considering a feasibility study of costs and benefits for tertiary treatment of wastewater at the WWTP. In addition, an application was filed in 1993 with the State Water Resources Control Board to obtain funding for tertiary treatment. The WWTP was subsequently notified in 1994 that they have been placed on the state priority list for such funding.

Potential Replenishment Projects. Potential replenishment projects can be grouped into two categories:

- Indirect or in-lieu replenishment involving use of non-potable water for industrial/dust control or landscaping purposes, or
- Direct artificial recharge.

The indirect or in-lieu replenishment projects result in conservation of groundwater for potable use by satisfying industrial or irrigation water demands with untreated surface water or reclaimed wastewater in lieu of groundwater. Water for industrial uses could be supplied by secondary reclaimed wastewater, but the quantity conserved in Scotts Valley would likely be small. Water for irrigation and landscaping may also be supplied by secondary reclaimed wastewater in place of groundwater.

Water for direct artificial recharge may be supplied by streamflow or reclaimed wastewater. Direct recharge of wastewater is highly regulated and constrained to protect public health. Current draft regulations for artificial recharge of reclaimed wastewater are shown in Table 4. For example, wastewater must account for less than 50 percent (with tertiary treatment including filtration) or 20 percent (with secondary treatment) of the total recharged water recovered in a well. In addition, nearby production wells within 500 to 2,000 feet of a recharge site may have to be abandoned as drinking water sources.

Specific potential sources of replenishment water include the following:

- Streamflow from Bean Creek,
- Streamflow from Carbonera Creek,
- Reclaimed wastewater,
- Local streamflow, and
- Watkins-Johnson remedial pumpage.

Bean Creek was eliminated as a source due to its sensitivity as a year-round fish and wildlife habitat. Watkins-Johnson was eliminated as a potential source because it is already being reused for other purposes. Therefore, the primary sources of water are Carbonera Creek (only during the wet season), reclaimed wastewater

TABLE 4
MINIMUM TREATMENT AND RECHARGE REQUIREMENTS FOR WASTEWATER RECYCLING

RECHARGE METHOD:	SURFACE SPREADING				DIRECT INJECTION
PROJECT CATEGORY:	I	II	III	IV	V
Maximum % reclaimed water in extracted groundwater	50	20	20	20	50
Depth to groundwater (feet) Initial percolation rate:					
<0.20 inches/minute	10	10	20	50	NA
<0.33 inches/minute	20	20	50	100	NA
Underground retention time (months)	6	6	12	12	12
Horizontal separation* (feet)	500	500	1000	1000	2000
Level of treatment:					
Oxidation	X	X	X	X	X
Filtration	X	X			X
Organics removal	X				X
Disinfection**	X	X	X		X

* From edge of recharge/spreading operation to nearest domestic supply well.
** Disinfection level varies.
REF: Proposed Title 22 Groundwater Recharge Regulations

(year-round), and local streamflow (only during the wet season).

Chemical analyses of water from Carbonera Creek evaluated in previous studies indicate that it is probably of satisfactory quality. Evaluation and correlation of streamflow data indicate that the average annual Carbonera Creek streamflow quantity is approximately 4,000 AFY. Reclaimed wastewater is currently discharged at a rate of approximately 900 AFY and meets secondary discharge (water quality) requirements. Local streamflow is derived primarily from residential area runoff. No water quality analyses are available, and thus the quality for recharge is unknown. The initial major storms of the wet season tend to result in the poorest runoff water quality and would not be retained for artificial recharge purposes. However, water from subsequent storms typically is of higher quality and probably would be suitable for recharge. The total quantity of local streamflow is estimated to be 1,200 to 2,200 AFY, although only a fraction could potentially be retained for recharge due to its flashy nature.

Based upon our review of previous studies and an assessment of the current conditions in Scotts Valley, the following potential projects were identified:

(1) Skypark basins,

(2) Carbonera Creek check dams,

(3) El Pueblo recharge wells,

(4) Kaiser sand pit,

(5) Bergstrom Cliffs check dams/El Pueblo sand pit, and

(6) Valley Gardens golf course irrigation.

The preliminary replenishment projects are summarized in Table 5 and described in the paragraphs below.

(1) Skypark basins.

Skypark, slated for residential development in the near future, is one of few large flat parcels that are suitable for artificial recharge. Based upon a review of various options, it is proposed that two recharge basins be built. One basin would be located near the center of the site and dedicated to year-round recharge. The source of water during the rainy season would be local runoff generated within the new development and local streamflow diverted from the adjacent Dufuors tributary. Reclaimed wastewater could be recharged during the dry season. A second seasonal recharge basin would be located along the eastern boundary of the site. The source of water for this basin would be local runoff and streamflow.

Estimates of the quantity of recharge at Skypark were based on the following assumptions: a conservative percolation rate of 1 foot/day, a wetted area of two acres for each basin, a fully wetted basin for 60 days during the rainy season, and 20 percent wastewater usage in the dedicated basin. These assumptions yield estimates of 120 AFY for the seasonal basin and 170 AFY for the dedicated basin, for a total potential recharge of 290 AFY. This estimate of potential recharge is lower than previous estimates, which assumed Carbonera Creek streamflow would serve as a source of recharge water for Skypark.

The estimates of recharge should be compared to the estimated

TABLE 5
SUMMARY OF GROUNDWATER REPLENISHMENT ALTERNATIVES

GROUNDWATER REPLENISHMENT ALTERNATIVE	SOURCE WATER TYPE/ MAXIMUM QUANTITY	QUALITY OF SOURCE WATER	EXPECTED RECHARGE QUANTITY	COMMENTS	POTENTIAL FOR RECOVERY
Skypark Basins	Local Streamflow/280 to 495 AFY	Unknown	Less Than 200 AFY	Not compatible with Kaiser, basin siting critical.	Wells 9 and 10
	20% Reclaimed Wastewater/56 to 99 AFY	Secondary Treatment			
Carbonera Creek Check Dams	Carbonera Streamflow/4,300 AFY	Satisfactory	Less than 100 AFY	Narrowing channel since 1980's.	Well 11 and El Pueblo
El Pueblo Recharge Wells	Carbonera Streamflow/4,300 AFY	Treatment Necessary	Unknown	Requires upgrade of treatment facility.	Well 11 or El Pueblo
Kaiser Sand Pit	Local Streamflow/280 to 495 AFY	Unknown	200 AFY	Not compatible with Skypark, outside SVWD boundaries, large storage capacity.	New recovery well or Well 10
	20% Reclaimed Wastewater/56 to 99 AFY	Secondary Treatment			
Bergstrom Cliffs/ El Pueblo Sand Pit	Local Streamflow/30 AFY	Unknown	20 to 30 AFY	Check dams may alleviate flooding problems.	Well 11 and El Pueblo
	Carbonera Streamflow/4,300 AFY	Satisfactory	270 AFY		
Valley Gardens Golf Course Irrigation	Reclaimed Wastewater/up to 900 AFY	Secondary Treatment	100 AFY	Replaces groundwater pumpage, potential impact on Well 10.	NA

Notes:
AFY=Acre–feet per year
NA=Not Applicable

quantity of available water. Local streamflow generated from a portion of Camp Evers and central Scotts Valley amount to 280 to 495 AFY, although only a portion of this amount may realistically be retained for recharge. In addition, a portion of local streamflow generated from runoff within the future Skypark development could also be retained. The amount of recharge actually achieved will depend on stream discharge and duration, size of diversion works, and available storage and recharge rate in the basins. Reclaimed wastewater also could be available for recharge, amounting to 20 percent of retained streamflow. Based on the limited quantity of local recharge water that realistically can be diverted, it is estimated that the amount of water that can be percolated at Skypark probably is 200 AFY or less.

A portion of recharged water at Skypark may be recovered with Wells 9 and 10. Some of the recharged water would also flow towards the Watkins-Johnson pumping depression and Bean Creek. Alternately, a new recovery well could be sited northwest of Skypark. Basin siting will be crucial at Skypark to maintain an acceptable distance from recovery wells (due to recharge of reclaimed wastewater), while still allowing for recovery of an acceptable portion of recharged water.

(2) Carbonera Creek check dams.

Carbonera Creek channel consists of alluvium overlying the Santa Margarita sandstone along a 3,700 foot stretch between Highway 17 and Bob Jones Lane. The creek flows generally from October through June with an average annual discharge of approximately 4,300 AFY.

The average annual flow during the past eight water years from October 1, 1985 to September 30, 1993 was approximately 2,750 AFY. These recent flows have been below average due to drought. Average annual recharge in the existing stream channel was previously estimated to be 176 AFY. Previous studies also indicated that modification of the channel with three check dams could increase recharge in the channel by an additional 136 AFY.

Based upon a May 1994 preliminary survey of stream characteristics, suitable locations for check dams exist between Carbonera Way and Bob Jones Lane. However, the morphology of the channel has changed significantly in recent years with a build-up of rather large, vegetated sand/silt bars. This has reduced the wetted channel area and likely has caused a reduction in natural stream recharge. Accordingly, the previous estimates of recharge using check dams also would need to be reduced. It is now estimated that the amount of recharge to be gained by three check dams is less than 100 AFY unless the channel is scraped out. A vacant parcel at the Carbonera Way crossing should be considered as a potential site for an off-stream spreading basin.

Recharged water could be recovered by Well 11 and the El Pueblo well field. However, the impact of contaminants in groundwater locally should be considered.

(3) El Pueblo recharge wells.

Recharge wells inject water directly into the aquifer, and thus require high quality source water, such as treated surface water or tertiary treated wastewater. Wastewater can constitute only up to

50 percent of recharged water, so an additional source of high quality water is needed for blending (see Table 4). A source of high quality recharge water would be available if Carbonera Creek water could be diverted to the water treatment facility at El Pueblo well field. However, the treatment facility would likely have to be upgraded to handle a higher capacity of water and to filter sediment.

Carbonera Creek water could be diverted by imbedding a perforated diversion pipe several feet below the channel bed. This would allow some natural filtration to occur through the sand in the channel bed. The creek water would then flow through the pipeline to the El Pueblo treatment facility. Following treatment, the water could be injected into Well 3A, Well 7 or a new injection well, and subsequently extracted through Well 11. The quantity of recharged water would be dependent upon available flow in Carbonera Creek, the capacity of diversion, transmission, and treatment facilities, and recharge capacity of the injection well.

(4) Kaiser sand pit.

Kaiser sand pit previously served as a recharge/disposal site for treated wastewater in the 1970's and early 1980's. In 1974, the majority of the wastewater treatment plant capacity of 100,000 gpd was disposed of at Kaiser sand pit. A 1974 study (Harding Lawson Associates, 1974) indicated that as much as 400,000 gpd (or 450 AFY) of reclaimed wastewater could be disposed of in the sand pit.

The sources of water are the same as those for Skypark. As with Skypark, the use of reclaimed wastewater would require a second source of water for blending. It is anticipated that local streamflow (amounting to 280 to 495 AFY) could serve as the other source of water unless it is diverted for other uses (such as Skypark). Based upon the available sources of water, it is estimated that the total quantity of recharge in Kaiser sand pit would potentially be greater than at Skypark because of the greater storage available in the sand pit. It is estimated to be approximately 200 AFY.

Although this site is located outside SVWD boundaries, a significant portion of recharged groundwater could be expected to flow north into SVWD boundaries. A portion of recharged water could potentially be recovered by Well 10 or a new recovery well located northwest of Well 10. Some recharged water would also be expected to flow toward Bean Creek.

(5) Bergstrom Cliffs check dams/El Pueblo sand pit. This site includes a small drainage watershed of about 45 acres and a relatively flat quarried area on Scotts Valley Drive at El Pueblo Road. It is estimated that an annual average runoff of 30 AFY would be available from the watershed. Check dams could be constructed along the drainage to retain water and percolate it into the permeable, underlying Santa Margarita sandstone. It is likely that much of the 30 AFY could be recharged.

A second phase of this project could involve construction of a three acre recharge basin, receiving water diverted from Carbonera Creek. Assuming the basin could remain wetted for 90 days per year with a conservative percolation rate of one foot per day yields a recharge quantity of 270 AFY. Recovery of the recharged water would be achieved through Wells 11, 3A, or 7. Wastewater recharge was not considered, as it would entail abandonment of Well 11 as a drinking water source.

(6) Valley Gardens golf course irrigation. Valley Gardens golf course consists of 33 acres including 1.5 acres of ponds and waterways. Groundwater is currently pumped into the ponds, which also serve as storage for irrigation water. A large portion of the irrigation needs of the golf course could be met with reclaimed wastewater. Valley Gardens has previously used on the order of 100 AFY of reclaimed wastewater for irrigation purposes. This conservation measure would indirectly benefit the water table by reducing pumpage in Valley Gardens' well. In addition, nearby residential developments with landscaped commons (i.e. Vista del Lago, Spring Lakes) may offer potential for irrigation with reclaimed wastewater. However, potential impacts on Well 10 would have to be considered.

Mitigation of Pumpage Impacts. In summation, groundwater storage declines in recent years have been on the order of 500 to 600 AFY. These declines are localized in the Camp Evers and Scotts Valley Drive areas, and reflect intensive pumpage from major municipal and private wells. Recovery of groundwater levels in these areas probably will require not only redistribution of groundwater production, but also increased conservation of water and active replenishment. Given the complexity of the local hydrogeologic setting, such active groundwater management will need to be based on a comprehensive, but detailed understanding of the local hydrogeology.

As indicated, alternatives exist for mitigation of the pumpage impacts in the Camp Evers and Scotts Valley Drive areas. It is likely that more than one replenishment project would be needed to offset the groundwater declines of 500 to 600 AFY experienced in recent years. Additional management, conservation, and replenishment efforts would be needed to provide for any additional increase in local water demands.

Replenishment projects can entail significant costs, and for that reason should be planned and implemented in the context of basin-wide water resource management and in coordination with SLVWD, Santa Cruz County, and other major groundwater users. This is particularly true in the Camp Evers area. Replenishment projects also should be supplemented with continued efforts to encourage conservation measures (such as low flow plumbing fixtures and drought resistant vegetation) and efforts to encourage wastewater reclamation and recycling.

Recommendations

- More than one project should be considered to mitigate local impacts of groundwater pumpage and to ensure long-term groundwater supply.

- Each project described in this section has been presented in a preliminary and conceptual manner. More detailed investigations would need to be carried out to further evaluate the proposed projects. Additional studies should include:
  1) The discharge of the Camp Evers tributary of Carbonera Creek should be measured periodically to determine this flow out of the basin. The contribution of landscaping ponds and waterways to this outflow should be assessed. If the contribution is significant, SVWD and SLVWD should encourage local landscaping entities to develop a joint landscaping water management plan, including determination and implementation of measures to mitigate this loss of water.
  2) Field work to evaluate subsurface stratigraphy, percolation rates, stream discharge/duration, and water quality.
  3) Computer modeling to evaluate mounding effects, subsurface retention times, and the ultimate destination of water originating from recharge facilities.
  4) Cost/benefit analysis to evaluate the actual cost per acre-foot of recharge water.
  5) Assessment of environmental impacts.
- All projects discussed in this section warrant further consideration, in addition to others that may be proposed.
- Replenishment projects should be planned and implemented in

the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

- SVWD, SLVWD and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.
- SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

Section 4

GROUNDWATER QUALITY

The natural quality of groundwater in the Scotts Valley groundwater basin is typically high. However, the occurrence volatile organic compounds in SVWD wells and the Manana Woods well has resulted in increasing concern over groundwater contamination and the lack of timely and effective source identification and remediation. The Santa Margarita aquifer is particularly vulnerable to contamination by leaks and spills at the surface due to the permeable nature of deposits which crop out at the ground surface. In 1982, the Santa Margarita groundwater basin was designated as a sole source aquifer by the USEPA. This means that the City of Scotts Valley and nearby communities use this aquifer as their sole or principal water supply. Therefore, it is deserving of special protection.

The discussion of groundwater quality presented here will focus on human-induced groundwater quality problems. This section will present the regulatory framework for the identification and remediation of contamination problems; areas of contamination identified in the Scotts Valley; and various groundwater contamination prevention programs and activities.

4.1 Regulatory Responsibilities

Several local, state, and federal agencies have responsibilities for preventing, identifying, and remediating groundwater contamination problems in Scotts Valley. These agencies include: the USEPA; the California Environmental Protection Agency, Department of Toxic Substance Control (Cal-EPA); the Regional Water Quality Control Board, Central Coast Region (RWQCB); and the Scotts Valley Fire Protection District (SVFPD). Generally, responsibility for potential contamination sites, suspected contamination sites, and actual contamination sites are distributed between these various agencies. The criteria for distribution of sites between the various agencies is somewhat vague; however, there are some guidelines for the allocation of responsibility.

At the local level, the SVFPD oversees the City of Scotts Valley's hazardous materials management program; implements state regulations for the installation, monitoring, use, and removal of underground storage tanks; and is the first responder in the event of a hazardous material release. The SVFPD also oversees monitoring well and deep soil boring installations and destructions. At the state level, the RWQCB regulates sites where groundwater contamination from underground storage tanks or other sources has occurred. Generally, Cal-EPA oversees sites where groundwater contamination has been detected but the potentially responsible party (PRP) has not been identified or the identified PRP is not financially solvent. At the federal level, the USEPA commonly oversees sites that are on, or proposed for, inclusion on the National Priority List (NPL) of federal Superfund sites.

SVWD is responsible for monitoring of its water supply and provision of water satisfying state and federal drinking water standards. Although SVWD does not have regulatory authority for the prevention, identification or remediation of contamination sites in Scotts Valley, several groundwater contamination problems have been discovered by SVWD through its regular monitoring of water supply wells. SVWD monitors the groundwater at its active water supply wells at least semi-annually, and monthly if constituents of concern are detected. Groundwater is sampled at the frequency specified and for the constituents required by Title 22, California Administrative Code, Chapter 15. Analyses which have been performed include: general mineral, physical, inorganic, radiological, bacteriological, and regulated and unregulated organics. Water quality data are compiled and analyzed by SVWD and its consultants; water quality concerns are discussed in the annual Scotts Valley Water Resources Management Plan reports (Todd Engineers, 1984 to 1994).

Identification of sources and remediation of groundwater contamination problems is often a slow and difficult process. As a result SVWD has been compelled to provide well head treatment for contaminated groundwater in order to provide water to its costumers which meets regulatory standards. To protect its production wells from the adverse effects of contamination SVWD has previously identified groundwater protection and management zones (Todd Engineers, 1988). Management and protection zones were delineated primarily on the basis of recharge areas, pumpage areas, and risk of contamination. Groundwater management and protection zones were further refined in the AMBAG study (Watkins-Johnson Environmental, Inc., September 1993).

4.2 Groundwater Contamination

Several areas of groundwater contamination have been identified in Scotts Valley as shown on Figure 10. Groundwater contamination problems include: benzene and 1,2-dichloroethane (1,2-DCA) identified in the Camp Evers area; chlorobenzene, dichlorobenzene and other solvents found along Scotts Valley Drive; and trichloroethene (TCE) and other solvents under remediation at the Watkins-Johnson site.

Camp Evers. Volatile organic compounds (VOCs) have been detected in three water supply wells in the Camp Evers area including the SVWD's Hidden Oaks well and Well 9, and the Manana Woods Mutual Water Company well (Manana Woods well). The Hidden Oaks well has shown detectable concentrations of a variety of VOCs in past sampling events including: benzene, ethylbenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-DCA, and xylenes. Well 9 and the Manana Woods well have shown detections of benzene only, with the exception of a single detection of 0.6 parts per billion (ppb) of 1,2-DCA in Well 9 in March 1994. The highest concentration of benzene detected has been 1,300 ppb, 39 ppb, and 9.4 ppb in the Hidden Oaks well, Well 9, and the Manana Woods well, respectively.

The RWQCB has identified ten possible sources of the contamination detected in these water supply wells (RWQCB, July 1993, September 1993, and April 1994). Figure 11 shows the wells that are monitored in the Camp Evers area, and the possible contamination source locations that have been investigated by the RWQCB. The highest concentration of benzene detected in wells along with the general groundwater flow direction are also indicated on the figure. The RWQCB has not yet found a definitive link between the contamination detected in water supply wells and any of the potential sources. Each of the potential sources is discussed below.

(1) Scotts Valley Middle School, 8 Bean Creek Road.
Two or three underground diesel tanks were removed from the site in 1988. Analyses performed on samples from a boring in the vicinity of the site showed no detected concentrations of VOCs. The RWQCB does not believe this site is a likely source of water supply well contamination.

(2) City of Scotts Valley, 370 Kings Village Road.
Two underground fuel tanks were removed from the Scotts Valley Old City Hall site. Soil samples taken during tank removal showed minor contamination (approximately 200 ppb total petroleum hydrocarbon). The RWQCB does not believe this site is a likely source of water supply well contamination.

(3) City of Santa Cruz, Skypark, Kings Village Road.
The Skypark Airport was operated in the past by the City of Santa Cruz. The Skypark property was recently annexed to the City of Scotts Valley. Four underground gasoline tanks were removed from

the site in 1984. Petroleum hydrocarbons were identified at elevated concentrations (6,400,000 ppb) in one of four soil borings at a depth of 15 feet. No gasoline hydrocarbons or benzene, toluene, ethylbenzene, or xylene (BTEX) compounds were detected in groundwater sampled from the Skypark Airport supply well. Petroleum hydrocarbons were detected at low levels (64 ppb) in a perched groundwater sample taken from a shallow soil boring (Weber, Hayes & Associates, 1994). The contamination associated with the underground tanks at Skypark appears to be localized. Remediation of soil contamination is being required. The RWQCB does not believe this site is a source of water supply well contamination.

(4) Hidden Oaks.

This site was used as an equipment storage yard in the past, and it is possible that petroleum products were spilled on the ground surface. No investigations have been performed at this site. The RWQCB has no evidence that this site is a source of water supply well contamination.

(5) Manana Woods.

The Manana Woods Mutual Water Company has at least two old wells on their site which could act as conduits to the aquifer. The RWQCB has no evidence that this site is a source of water supply well contamination.

(6) BP Service Station, 201 Mount Hermon Road.

Minor hydrocarbon soil contamination was detected at this site when fuel tanks were replaced with double walled tanks. Groundwater contaminated with petroleum hydrocarbons has been detected at the site; however, higher levels of contamination have been detected upgradient of the site at the Unocal Service Station. The RWQCB does not consider this site a likely source of water supply well contamination.

(7) Unocal Service Station, 99 Mount Hermon Road. Groundwater and soil contaminated with petroleum hydrocarbons were discovered at this site in October 1986. Remediation at the site has included replacement of four underground storage tanks and a waste oil tank in November 1990 with new double walled tanks, removal of 730 cubic yards of hydrocarbon affected soil around the tanks, installation of 18 monitoring wells, operation of a groundwater extraction and treatment system, and operation of a vapor extraction system. Recent sampling of wells downgradient from the Unocal site indicate that groundwater contamination is localized (RESNA, 1994). The RWQCB will consider the Unocal plume delineated and therefore not a source of water supply well contamination if additional monitoring confirms recent results.

(8) Shell Service Station, 90 Mount Hermon Road. Groundwater and soil contaminated with petroleum hydrocarbons have been discovered at and downgradient of the site (Pacific Environmental Group, 1993). Three underground fuel tanks at the site were replaced with double walled tanks. A soil vapor extraction system has been proposed to remediate soil contamination at the site. A former Chevron Service Station, which shows higher levels of soil and groundwater contamination than the Shell site, is located downgradient. As this site is located upgradient of a

source with higher concentrations of contaminants, this site could be at most a minor contributor to water supply well contamination.

(9) Former Chevron Service Station, 200 Mount Hermon Road. Groundwater contaminated with petroleum hydrocarbons have been discovered at and downgradient of the site. 1,2-DCA has also been detected in onsite monitoring wells. One set of underground tanks located on the east site of the site were probably removed around 1963 when new tanks were installed on the west side of the property (Pacific Environmental Group, January 1994). These three newer underground fuel tanks and one waste oil tank were removed in 1982. Recent groundwater sampling indicated elevated levels of benzene detected downgradient of the site (Pacific Environmental Group, March 1994). The RWQCB considers this site a possible source of water supply well contamination.

(10) Former ARCO Service Station, 4253 Scotts Valley Drive. Preliminary investigations have found two previously unknown underground tanks still in the ground at this site. Soil samples have been taken at the site and the results are pending. Further investigation will be performed to determine if a gasoline release occurred at this site. The RWQCB currently has no evidence that this site is a source of water supply well contamination.

Figure 12 shows the highest concentration of benzene detected in 1993-1994 in monitoring wells located at the intersection of Mount Hermon Road and Scotts Valley Drive. As shown, the highest concentrations of benzene are detected in the vicinity of the former Chevron Station. General groundwater flow is to the west and northwest, or in other words, from the vicinity of the Mount Hermon/Scotts Valley Drive intersection towards the affected wells. Accordingly, the groundwater flow direction and distribution of benzene in the area of the service stations indicate that this area probably is a source of contamination in the water supply wells. Accordingly, the Camp Evers benzene problem probably is a single extensive plume as illustrated on Figure 10.

El Pueblo Road. Three separate VOC problems have occurred in the El Pueblo Road area (between Scotts Valley Drive and Highway 17) affecting four SVWD water supply wells. The affected wells include Wells 6, 3A, 7 and 11. Tetrachloroethene (PCE) was detected first in Well 6 in 1984, and was consistently detected at low concentrations (less than 2.2 ppb) from 1984 to 1986. However, sampling performed in late 1986 and 1988 showed no detected concentrations of PCE. Well 6 is no longer in service. Second, TCE was detected in Wells 3A and 7 in 1984. However, VOCs have not been detected in these two wells since September 1991. A third problem was identified when chlorobenzene was detected in 1991 in Well 11. Chlorobenzene and dichlorobenzene were detected in varying concentrations in several other local wells during sampling performed in 1986 and 1988. Chlorobenzene was detected at 2.8 ppb in Well 11 during the most recent sampling event in March 1994. Figure 13 shows the approximate extent of the chlorobenzene plume based on the highest concentrations detected in Well 11 and other wells in the area.

Cal-EPA is the lead agency overseeing characterization and remediation of contamination detected in the El Pueblo Road area. Identification of possible sources of contamination in the El Pueblo Road area has been the focus of investigation for a number of years (California Department of Health Services (DHS), 1987 and 1988). The USEPA funded a study to identify current and past hazardous materials users in the area (Ecology & Environment, Inc., 1986). Priority sites were inspected for use and hazardous materials management practices. Several potential sources of contamination in the area have been identified; however, to date the source or sources of elevated chlorobenzene detected in Well 11 have not been determined (PRC Environmental Management, Inc., 1993). A discussion of potential sources of contamination detected in SVWD water supply wells is presented below.

(1) Scotts Valley Circuits, 66 El Pueblo Road.

VOCs have been detected in soil and groundwater at the Scotts Valley Circuits site. VOCs in soil were first detected at the site in December 1988 in the vicinity of an underground wastewater treatment sump, which is thought to be the primary source of contamination. Chemicals detected in perched groundwater at the site include: PCE, TCE, trichloroethane (TCA), dichloroethene (DCE), dichloroethane (DCA), benzene, toluene, and xylenes. Monitoring wells at the site are screened opposite this perched groundwater zone; however, deeper groundwater monitoring at the site has not been performed. Scotts Valley Circuits has completed a Remedial Investigation (On-Site Technologies, 1992 and 1993), and a Feasibility Study (Cypress Environmental, 1993). The preferred remedial alternative is soil excavation, vapor extraction, and perched groundwater extraction and treatment. A final remedial action plan remains to be drafted and approved by the Cal-EPA following the results of a treatability study. The Scotts Valley Circuits site is a possible source of the contamination detected in Wells 3A and 7.

(2) Former Technical Plastics (Currently Seagate Technology and Si-Fab Corporation), 19 and 27 Janis Way.

Hazardous materials may have been disposed onsite. Soil sampling conducted in 1990 found various chemicals in the soil including: toluene (less than 6 ppb), PCE (2 ppb), ethylbenzene (less than 450 ppb), xylene (less than 100 ppb), 4-methyl,2-pentanone (3 ppb), hexanone (14 ppb), and styrene (less than 980 ppb). This site has moderate potential for release of contaminants to groundwater.

(3) J&E Machine (Currently Ashland Machines), 5998 Butler Lane.

The site was operated by J&E Machine from 1980 to 1986 and was cited by the RWQCB in 1984 for illegal discharge of TCE to Carbonera Creek and illegal hazardous waste storage. The site reportedly contained a 5,000 gallon underground storage tank. This site was given a high priority for further sampling by the Ecology and Environment, Inc. study; however, it appears that no further sampling has been performed at this site.

(4) Tate Western, 340-F El Pueblo Road.

Soil contamination with toluene (less than 6,300 ppb) was detected on an adjacent property due to Tate Western chemical handling activities. Approximately 36 cubic yards of affected soil and 3,000 gallons of contaminated rain water were removed from the site. No further sampling was recommended in the Ecology & Environment, Inc. study.

(5) Pettibone Signs, 17 Janis Way.

Small quantities of wastes may have been disposed onsite. This site was given a medium priority for further sampling in the Ecology & Environment, Inc. study. It does not appear that any additional sampling has been performed at this site.

(6) Carbonera Trailer Park, Disc Drive.

Chlorobenzene (76 ppb) and dichlorobenzene (1,100 ppb) have been detected in two groundwater wells located at this site. These concentrations are the highest detections of chlorobenzene and dichlorobenzene in groundwater in the El Pueblo Road area. No soil sampling has been done at this site. Due to the relatively high detections in wells on the site, a possible source may be located nearby.

(7) Septic Systems, regional.

All facilities in the El Pueblo Road area used septic systems and leach fields until 1970 to dispose of sanitary wastewater. Between 1970 and 1975, sewers were installed. Discussions with the Scotts Valley Department of Public Works indicates that a small percentage of businesses scattered around the city could still be on septic systems. Improper disposal of chemicals into septic systems and leach fields could result in groundwater contamination. Septic system cleaners have in the past contained hazardous chemicals including orthochlorobenzene. There is a potential for inactive and active septic and leach field systems in the area to contribute to groundwater contamination.

Watkins-Johnson. Watkins-Johnson is located at 440 Kings Village Road adjacent to the Skypark Airport on the western perimeter of the City of Scotts Valley. Investigations initiated in 1984 found a number of organic compounds in soil and groundwater at the site. Site characterization and remedial activities were originally overseen by the RWQCB; currently the USEPA provides regulatory guidance because Watkins-Johnson is a proposed NPL site. A dilution tank located on the site and removed in 1987 is the major suspected source of site contamination. In the vicinity of the Watkins-Johnson site, the Santa Margarita aquifer is comprised of a perched and regional zone. TCE is the key constituent detected in perched and regional groundwater (Watkins-Johnson Environmental, Inc., April 1989). In 1987, a program of aquifer restoration was initiated (Watkins-Johnson Environmental, Inc., November 1989). Operation of remedial facilities at the site has reduced the extent of groundwater contamination at the site to within site boundaries. The Watkins-Johnson site is not a suspected source of contamination to water supply wells.

Other Identified Contamination Sites. Several other leaking underground storage tanks sites have been identified in Scotts Valley. These sites include:

- Jeff Mora Property, 5276 Scotts Valley Drive,
- Exxon Station, 5620 Scotts Valley Drive,
- Chevron Station, 6012 Scotts Valley Drive,
- Shell Station, 1 Hacienda, and
- Fast Gas, 5451 Scotts Valley Drive.

These sites show minor contamination which is either confined onsite or has been remediated to low levels. These sites are not likely sources of water supply well contamination.

4.3 Groundwater Contamination Prevention

Groundwater contamination prevention programs are the best strategy for minimizing future groundwater contamination problems. This is particularly true in Scotts Valley because of the permeability and susceptibility of local aquifers to contamination, difficulty in determining the sources of groundwater contamination, extended periods of time and high costs required to remediate known contamination problems, and added cost of wellhead treatment by water purveyors.

There are a number of groundwater contamination prevention activities which have been or could be implemented in Scotts Valley. The topics related to groundwater protection discussed in the following sections include well construction, abandonment, and destruction; hazardous material management; underground storage tanks; septic tank disposal systems; and city planning and zoning. These activities are performed by various state and local agencies. While SVWD has some responsibility for the construction and destruction of supply wells, the prevention of groundwater contamination requires the cooperation of a number of local and state agencies. The regulatory framework for the implementation of groundwater prevention programs is discussed at the end of this section. Recommendations to improve groundwater protection are presented at the end of each section.

Well Construction, Abandonment, and Destruction. Water wells connect the ground surface to the aquifer, and can connect one aquifer to another; consequently they can act as conduits for the transmission of pollutants from the land surface to the aquifer or from a shallower aquifer to a deeper aquifer. However, properly constructed and destroyed wells are engineered to minimize such mechanisms of transmission.

Responsibility for regulation of the construction, abandonment, and destruction of water wells is divided between the DWR, SVWD, Santa Cruz County, SVFPD, and the USEPA. The California Water Code Section 231 requires the DWR to develop well standards to protect California's water quality. DWR Bulletin 74-81 (1981) and supplemental Bulletin 74-90 (1991) contain the minimum requirements for constructing, altering, maintaining, and destroying wells. Local governments may have more stringent standards than those of the DWR. In Scotts Valley, DWR standards for the permitting, construction, abandonment, and destruction of water supply wells are enforced by SVWD and Santa Cruz County; while the permitting, construction, abandonment and destruction of monitoring wells and soil borings are enforced by the SVFPD.

A database of domestic, industrial, and municipal water supply wells and around the SVWD boundaries has been compiled by Todd Engineers. The database documents the well owner, location, uses, and construction and hydrogeologic information. Figure 14 shows the locations of known private, irrigation, industrial and municipal water supply wells in and around Scotts Valley. As can be seen on the figure, many wells have been constructed, with at least 100 wells drilled within the district boundaries. A review of the water well drillers reports show that many of these wells are old and screened at relatively shallow depths. It is likely that many of these wells are no longer in use and have been destroyed; however, documentation of well destructions is scarce and in many cases does not exist. It is likely that some of these wells have been lost or covered over at the surface and have not been properly destroyed. These lost and abandoned wells provide a potential conduit for the migration of contaminants from the ground surface to the depth penetrated.

In addition, since small private groundwater users in Scotts Valley are not well documented, it is not clear whether some private well users may be consuming groundwater that is contaminated with low levels of VOCs. There is no mechanism currently in place, other than newspaper articles, to inform small private well owners of contamination problems.

The SVFPD implements DWR standards and the more strict standards for monitoring wells that were developed by the Santa Clara Valley Water District (SCVWD, 1989). The SVFPD keeps records of all monitoring well installations in Scotts Valley with the exception of monitoring wells installed at the Watkins-Johnson site, which are regulated by the USEPA. There are 87 groundwater monitoring, vadose zone monitoring, groundwater recovery, and vapor extraction wells documented in SVWPD records. An additional 51 monitoring wells are located on and around the Watkins-Johnson facility.

To date, Scotts Valley has had no documented problems associated with old wells acting as conduits for the migration of contaminants. Nonetheless, prevention of future problems can be facilitated by better documentation of existing wells and stricter enforcement of DWR guidelines.

Recommendations

- Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.
- Document the status of wells within the SVWD boundaries and update well inventory database (i.e. identify and inventory active and destroyed wells).
- Establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

- Given the existence of multiple aquifer systems within SVWD, implement well construction standards to prevent cross-contamination of aquifers (i.e. installation of conductor casings and minimum seal depths).
- Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.
- Establish a program to identify (e.g. during real estate property transfers) and encourage the proper destruction of abandoned wells within the SVWD boundaries.

Hazardous Materials Management. Hazardous materials users pose a threat to groundwater quality through accidental or intentional surface spills, leaking underground storage tanks, and improper handling, storage, and disposal. It should be noted that the general public also handles hazardous wastes in the form of paints, fertilizers, pesticides, household cleaners, and waste oil.

The SVFPD is the local agency which oversees hazardous materials management for the City of Scotts Valley, while hazardous wastes are regulated by the Santa Cruz County Health Services Agency, Environmental Health Service (Santa Cruz County). Santa Cruz County also oversees the household hazardous waste programs in Scotts Valley. The hazardous materials management program as implemented by the SVFPD is intended to insure that hazardous materials are properly stored and monitored, that leaks and spills are detected in a timely manner, and that proper reporting and corrective actions are taken in the event of a leak or spill. A Hazardous Materials Management/Business Plan (HMMP) must be submitted by businesses or individuals who use or store toxic chemicals or hazardous materials over certain volumes, as part of the application for a Hazardous Materials Permit. The HMMP contains information on types and volumes of hazardous materials used, storage, and safety procedures.

A risk management and prevention program (RMPP) is required if a location stores or uses extremely or acutely hazardous material. No business in Scotts Valley has been required to file a RMPP.

Figure 15 shows the locations of hazardous materials users in Scotts Valley on file at the SVFPD. Sixty-four facilities have been identified as hazardous materials users in Scotts Valley. As shown, hazardous materials users are clustered along Scotts Valley Drive and between Scotts Valley Drive and Highway 17. There are no hazardous waste transfer, treatment, storage, and disposal facilities (TSDF) in Scotts Valley.

Recommendations

It is recommended that SVWD cooperate with the city and other agencies to:

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Consider stricter regulations for hazardous material users.

Underground Storage Tanks. The SVFPD implements state regulations for the installation, monitoring, use, and removal of underground storage tanks (USTs) in Scotts Valley. The SVFPD keeps a database that documents the locations, status, capacity, construction, and contents of USTs in Scotts Valley. The UST information is reported to State Water Resources Control Board (SWRCB).

Review of SVFPD records show that there are 37 active USTs located at 13 sites in Scotts Valley. Of the 37 active USTs, 15 are single-walled, and 22 are double-walled and meet new tank requirements for UST construction and monitoring standards. At least 50 USTs within Scotts Valley have been removed, while one tank was identified as closed in place and two previously unknown tanks are scheduled for removal. Figure 15 shows the locations of active, inactive, removed, and closed-in-place USTs in Scotts Valley, most of which are located along Scotts Valley Drive. Because of the density of USTs and other hazardous material use, this area has a high potential for release of pollutants to groundwater and surface water. It should be noted that it is likely that USTs may exist which have not been documented. Two recently discovered tanks on Scotts Valley Drive attest to this possibility. Other USTs may have been removed prior to institution of inspection programs without proper testing to determine if the tanks had leaked.

Chapter 6.7, Division 20 of the Health and Safety Code and the California Underground Storage Tank Regulations (Subchapter 16 of

Title 23 CCR), established a program for regulation of USTs that requires local implementing agencies to permit, inspect, and oversee monitoring programs to detect leakage of hazardous materials from USTs. The following requirements for new and old USTs are among those described in the California Underground Storage Tank Regulations.

New tank construction standards require that all new USTs (including associated piping) used for the storage of hazardous substances shall be required to have primary and secondary levels of containment. New tank monitoring standards require that all exterior surfaces of the USTs and the surface of the floor directly beneath the USTs shall be capable of being monitored by direct viewing. The liquid level in the USTs shall be recorded at the time of each inspection. The secondary containment system shall be equipped with a continuous monitoring system that is connected to an audible and visual alarm system.

The observation of any liquid around or beneath a UST shall require the owner/operator to undertake the following action or actions:

1) Conduct an appropriate laboratory or field analysis of the observed liquid. If the liquid is a hazardous substance, proceed with actions 2 and 3 below.
2) Conduct an appropriate tank integrity test.
3) If a leak is confirmed, immediately remove all hazardous substances from the UST and the secondary containment system.

Old tank monitoring standards apply to owners of existing USTs that do not meet new tank construction requirements. These standards require implementation of a monitoring program that is capable of detecting any unauthorized release from any portion of the UST system at the earliest possible opportunity. The monitoring program shall include visual and non-visual monitoring.

The owner or operator shall undertake all of the following activities if any liquid around or beneath an old UST is observed:

1) Any and all action necessary shall be taken to promptly determine if the observed liquid constitutes an unauthorized release.
2) Observed liquid shall be analyzed in the field or laboratory to determine if an unauthorized release has occurred.
3) The UST shall be tested utilizing a quantitative release detection method.
4) If the above steps indicate that an unauthorized release has occurred, the owner or operator shall replace, repair or close the UST.

The California Trade and Commerce Agency, Office of Small Business offers low interest loans for repairing underground petroleum storage tank projects (RUST). Qualified businesses have total resources not exceeding 21 million dollars over a three year period. Eligible projects include the upgrade, repair, or removal of underground storage petroleum products. Measures can also include minor cleanup. Loan amounts are from $10,000 to $350,000 with low, fixed-rate financing, and up to 20 years to repay.

The California State Legislature created the UST Cleanup Fund (SB 2004) to provide funding to eligible UST owners and operators for the cleanup of contaminated soil and groundwater caused by leaking petroleum USTs. Owners/operators of petroleum USTs are eligible for funding if they meet the following requirements:

1) There has been an unauthorized release of petroleum from the UST reported to and confirmed by the regulatory agency.
2) As a result of this unauthorized release, the owner/operator must take corrective action as required by a regulatory agency.
3) The owner/operator must be in compliance with any applicable financial responsibility requirements and by UST requirements.

The maximum amount available from the UST Cleanup Fund per occurrence is $990,000. Claimants are responsible for the first $10,000 of eligible corrective costs.

It is clear that leaking USTs have been a serious groundwater contamination source in Scotts Valley. Several sites have been identified where leaking USTs have impacted groundwater. The high cost and extended time required to identify and remediate these sites makes the prevention of leaks a desirable alternative. Single walled tanks pose a particular hazard because leakage is often not detected until a release has occurred. The current application of state standards to the use, monitoring, and removal of USTs may not provide adequate protection to the groundwater resources of Scotts Valley. Although SVWD has no regulatory authority over USTs, SVWD should encourage stricter regulation.

Recommendations

SVWD should cooperate with the City of Scotts Valley and other agencies to:

- Develop more stringent local standards for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

Septic Tank Disposal Systems. Septic tanks and cesspools are one of the most frequently reported sources of groundwater contamination in the United States. Prior to 1964, all of Scotts Valley used septic systems, leach fields and cesspools for the disposal of wastewater. The first sewage treatment plant in Scotts Valley was built in 1965 and sewer lines were extended to various areas over a period of years. For example, homes and facilities in the El Pueblo Road area used septic systems and leach fields until 1970, while some residential neighborhoods located along Lockewood Lane south of Mount Hermon Road were not sewered until the mid-

1980s. Four major outlying residential areas still rely upon septic systems for waste disposal (Figure 16). Currently, all businesses and private residences within 200 feet of sewer lines are required to hook into the sanitary sewer system. Discussions with the Scotts Valley Department of Public Works indicate that a small percentage of businesses and private residences (less than 5 percent) scattered around the city could still be on septic systems.

In the past, problems with elevated nitrate concentrations in groundwater have been attributed in part to use of residential septic systems. In addition, improper disposal of chemicals into septic systems and leach fields can result in the release of metals and organic constituents to groundwater. Septic system cleaners and drain cleaners contain hydrocarbons and chlorinated hydrocarbons which can leach into groundwater.

Recommendations

SVWD should cooperate with the City of Scotts Valley to:

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system; and
- Encourage all businesses and residences not currently hooked to the sanitary sewer system to connect to system.

City Planning and Zoning. A city zoning map, Figure 17, shows the distribution of land use in the City of Scotts Valley. Light industrial and commercial service zones are shown to be concentrated along Scotts Valley Drive and Highway 17 and along Mount Hermon Road. These zones represent the areas of greatest risk to groundwater quality because they are current and potential locations of hazardous materials users, USTs, and potential sources of contaminant release. These areas have been recognized as "high risk" (Todd Engineers, 1988), and as needing greater management. Accordingly, groundwater prevention programs by the City and other agencies should focus on these areas as a first priority. On its part, SVWD should continue its policy of limiting groundwater supply development in shallow aquifers in these areas. In addition, SVWD should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

Recommendations

SVWD should encourage the City to:

- Limit future industrial and commercial service development to existing areas.
- Encourage greater consideration by City planners of groundwater protection issues in land use planning.

Summary. In summation, the Scotts Valley groundwater basin is locally susceptible to groundwater contamination, and has experienced serious local groundwater contamination problems.

Several local, state, and federal agencies share responsibility for groundwater protection and remediation in Scotts Valley. However, no single regulatory agency has a regional outlook or authority on groundwater contamination problems.

SVWD does not have authority for the prevention, identification, or remediation of contamination sites. It does have some authority over the construction, abandonment, and destruction of water wells, and specific recommendations are provided to aid groundwater contamination prevention through this limited authority. However, SVWD is responsible for monitoring its groundwater supply and providing water satisfying state and federal drinking water standards. Given this responsibility, SVWD has delineated zones of groundwater contamination risk and has pursued a policy of developing groundwater supplies in areas and aquifers of low contamination risk. In addition, SVWD provides wellhead treatment for contaminated groundwater affecting some of its wells.

SVWD also monitors the status of groundwater contamination sites that pose a potential threat to groundwater resources, and to SVWD wells. Generally, key reports are sent to the SVWD; however, no official policy or agreement exists whereby SVWD is automatically and fully informed of groundwater contamination problems. Given SVWD's existing role and proven record in monitoring local water resources, and its critical responsibility in providing safe drinking water, SVWD should be automatically and fully informed of groundwater contamination situations. This information will become increasingly important if artificial recharge or other local groundwater supply management efforts are implemented in the Camp Evers or Scotts Valley Drive areas. In turn, SVWD could help to provide a regional overview and aid in information sharing among agencies.

Section 5

CONCLUSIONS

Conclusions of each of the major sections of the report are summarized below.

HYDROGEOLOGY

1. The areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited.
2. Much valuable information is available on the hydrogeology of the margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

GROUNDWATER SUPPLY

Monitoring

3. The water resource monitoring program is comprehensive, with an appropriate focus on the developed portions of the basin.

Groundwater Level Trends

4. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and a somewhat lower groundwater quality.

5. The wet 1992-1993 season resulted only in a moderation of the extent and severity of localized groundwater level declines.

6. Although affected by recent drought, Bean Creek responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

Perennial Yield and Groundwater Storage

7. Perennial yield for the Scotts Valley groundwater basin has been estimated to be 4200 acre-feet/year. This is an average annual value and is relevant to the area of the Scotts Valley groundwater basin.

8. Groundwater storage in the developed portion of the basin has declined between April 1986 and April 1994 by an estimated 500 to 600 acre-feet/year, or about 10 percent of estimated total groundwater storage.

AMBAG Model

9. The model can be used to observe effects of proposed well locations and pumping configurations and potential recharge projects, consequently aiding in groundwater management.

10. The model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

Pumpage

11. About 70 percent of the total estimated groundwater production is metered by SVWD, SLVWD, Watkins-Johnson, and the Mount Hermon Association. Groundwater production was estimated for other groundwater users, including landscape irrigators, private water

purveyors, commercial and industrial firms, and domestic users.

12. Total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks.

13. The estimated total groundwater pumpage amounts to over 80 percent of the estimated 4,200 AFY of perennial yield for the Scotts Valley groundwater basin, and is concentrated in the southeast one-quarter of the groundwater basin.

14. The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. SVWD efforts should be supplemented by additional actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs.

Replenishment

15. More than one replenishment program will be needed to mitigate localized groundwater level declines and to ensure long-term groundwater supply.

16. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each.

GROUNDWATER QUALITY

Regulatory Responsibilities

17. The Scotts Valley Fire Protection District oversees the City of Scotts Valley's hazardous materials management program,

implements state regulations of underground storage tanks, oversees monitoring and soil boring installation and destruction, and responds first to a hazardous material release.

18. The California Regional Water Quality Control Board (RWQCB) regulates sites where groundwater contamination occurs from underground tanks or other sources.

19. The California Environmental Protection Agency (Cal-EPA) oversees groundwater contamination sites where the potentially responsible party is not known or is not financially solvent.

20. The United States EPA oversees sites that are on or proposed for the Superfund list.

21. The Scotts Valley Water District does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of water satisfying state and federal drinking water standards.

Groundwater Contamination

22. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible sources.

23. Cal-EPA is the lead agency overseeing the characterization and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the TCE and chlorobenzene problems. Of seven possible sources, Scotts Valley Circuits has been identified as a possible source of TCE

contamination. A Remedial Investigation and Feasibility Study for the site have been prepared; a remedial action plan remains to be drafted and approved.

24. The United States EPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

Groundwater Contamination Prevention

25. Prevention of groundwater contamination in Scotts Valley is important because of the susceptibility of aquifers to contamination, difficulty in determining sources of contamination, extended time and high costs to remediate contamination, and added costs of wellhead treatment by water purveyors.

26. Improperly constructed or abandoned wells can provide conduits for downward migration of contaminants from the ground surface.

27. SVWD and Santa Cruz County share responsibility for enforcing standards for permitting, construction, abandonment, and destruction of water supply wells.

28. Sixty-four facilities using hazardous materials exist in Scotts Valley, located mostly along Scotts Valley Drive.

29. Thirty-seven active underground storage tanks have been identified in Scott Valley, of which 22 are double-walled and meet new tank standards.

30. Septic tanks represent other potential sources of contamination.

Section 6

RECOMMENDATIONS

HYDROGEOLOGY

1. Groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

GROUNDWATER SUPPLY

Monitoring

2. Continue data compilation on wells and geology and the program of climatic, surface water, and groundwater monitoring with annual reporting.

3. Encourage coordination of groundwater level monitoring by all agencies so that the quarterly measurements occur within a small time period, such as one week.

4. Expand data compilation and monitoring as groundwater exploration and production are extended into new areas, or as needed for groundwater replenishment projects or for groundwater contamination investigations or remediation.

Perennial Yield and Groundwater Storage

5. The perennial yield and groundwater storage of the Scotts Valley groundwater basin should be reevaluated in greater detail.

AMBAG Model

6. The model should be maintained, but revised as additional hydrogeologic and groundwater production data become available.

Pumpage

7. Information on wells and metered groundwater production should be compiled and updated regularly. Groundwater production by large groundwater users should be measured.

8. Following metering of major groundwater producers, consumptive use of groundwater should be analyzed.

9. SVWD should continue its efforts to redistribute its pumpage throughout its service area.

10. Roundtable meetings should be convened by the major groundwater producers to discuss means to analyze and mitigate groundwater level declines.

Replenishment

11. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

12. The conceptual replenishment projects, in addition to others that may be suggested, should be considered in greater depth. Additional investigations would include field work, computer modeling, cost/benefit analysis, and assessment of environmental impacts.

13. SVWD, SLVWD and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.

14. SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

GROUNDWATER QUALITY

SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. However, SVWD and Santa Cruz County share responsibility for enforcing standards for construction, abandonment, and destruction of water supply wells. Accordingly, specific recommendations for SVWD are as follows:

Well Construction, Abandonment, and Destruction

15. Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.

16. Conduct a survey to document the status of wells within SVWD boundaries, and to identify both active and destroyed wells.

17. Once the well survey is complete, establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

18. Given the existence of multiple aquifer systems within SVWD implement well construction standards to prevent cross-contamination of aquifers (i.e. installation of conductor casings and minimum seal depths).

19. Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.

20. Establish a program to identify (e.g. during real estate property transfers) and encourage the proper destruction of abandoned wells within SVWD.

21. In addition, SVWD is responsible for provision of water satisfying state and federal drinking water standards. Accordingly, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination. SVWD should also consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

The remaining recommendations, grouped according to the specific areas of groundwater contamination prevention, are long-term and require cooperations between agencies.

Hazardous Materials Management

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Consider stricter regulations for sites which use hazardous materials.

Underground Storage Tanks

- Develop more stringent local standard for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

Septic Tank Disposal Systems

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system.
- Encourage hookup of all businesses and residences not currently connected to the sanitary sewer system.

City Planning and Zoning

- Limit future industrial and commercial service development to existing areas.
- Encourage greater consideration by City planners of groundwater protection issues in land use planning.

Overall SVWD should encourage and cooperate fully with responsible agencies in the investigation and remediation of contamination sites, and in the identification of potentially responsible parties. SVWD also can provide a regional groundwater management overview and aid in information sharing among agencies.

Section 7

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Scotts Valley, California

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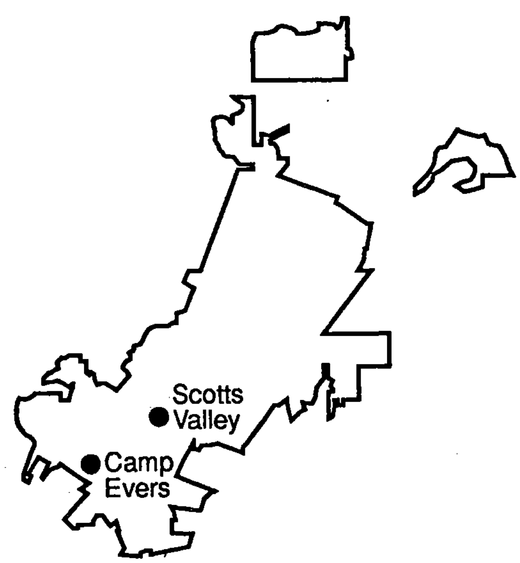
SCOTTS VALLEY GROUNDWATER MANAGEMENT PLAN (AB 3030)

July 1994



David Keith Todd
Consulting Engineers, Inc.
Berkeley, California

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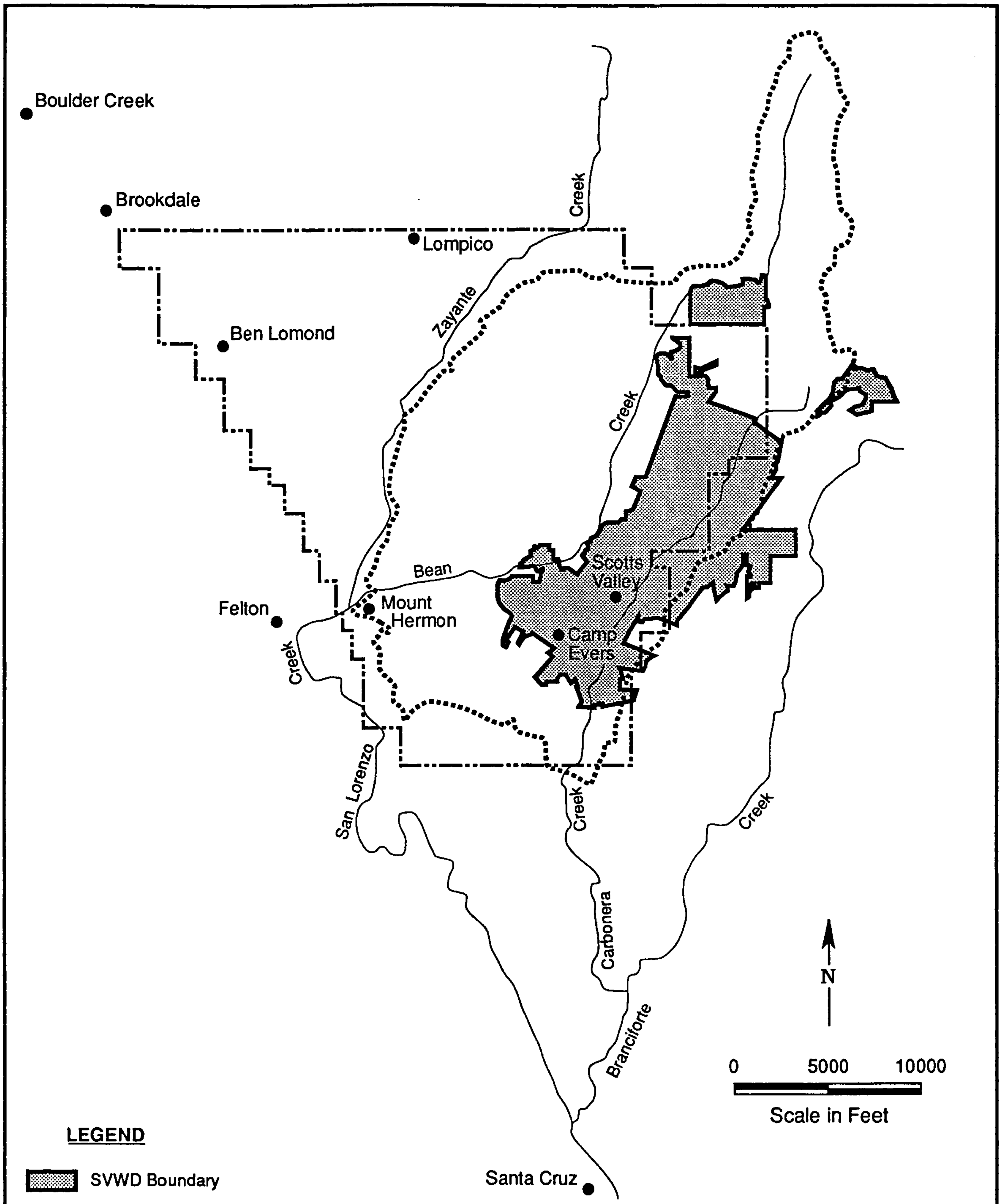

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Figure 1
Study Areas

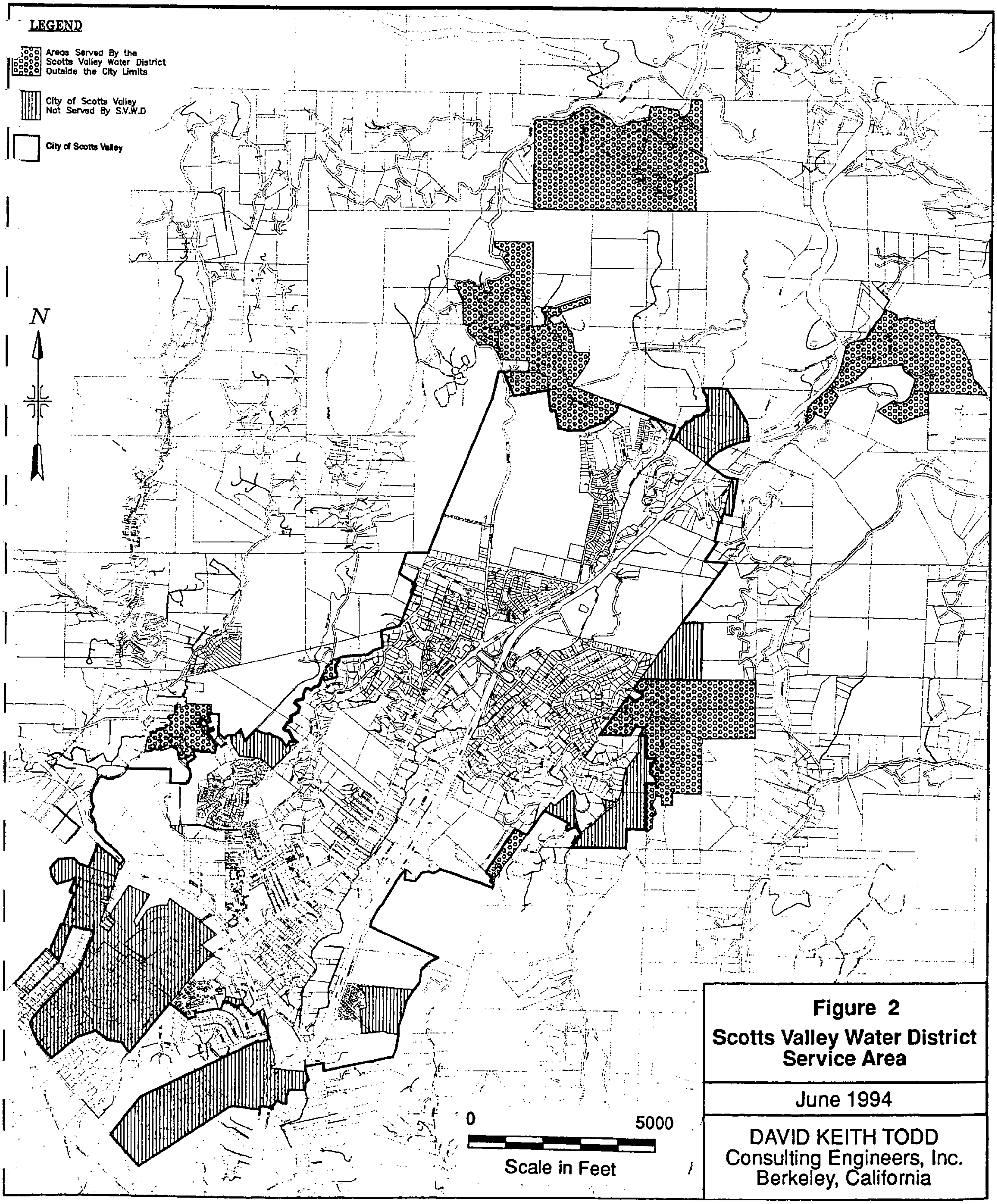

Figure 2
Scotts Valley Water District Service Area

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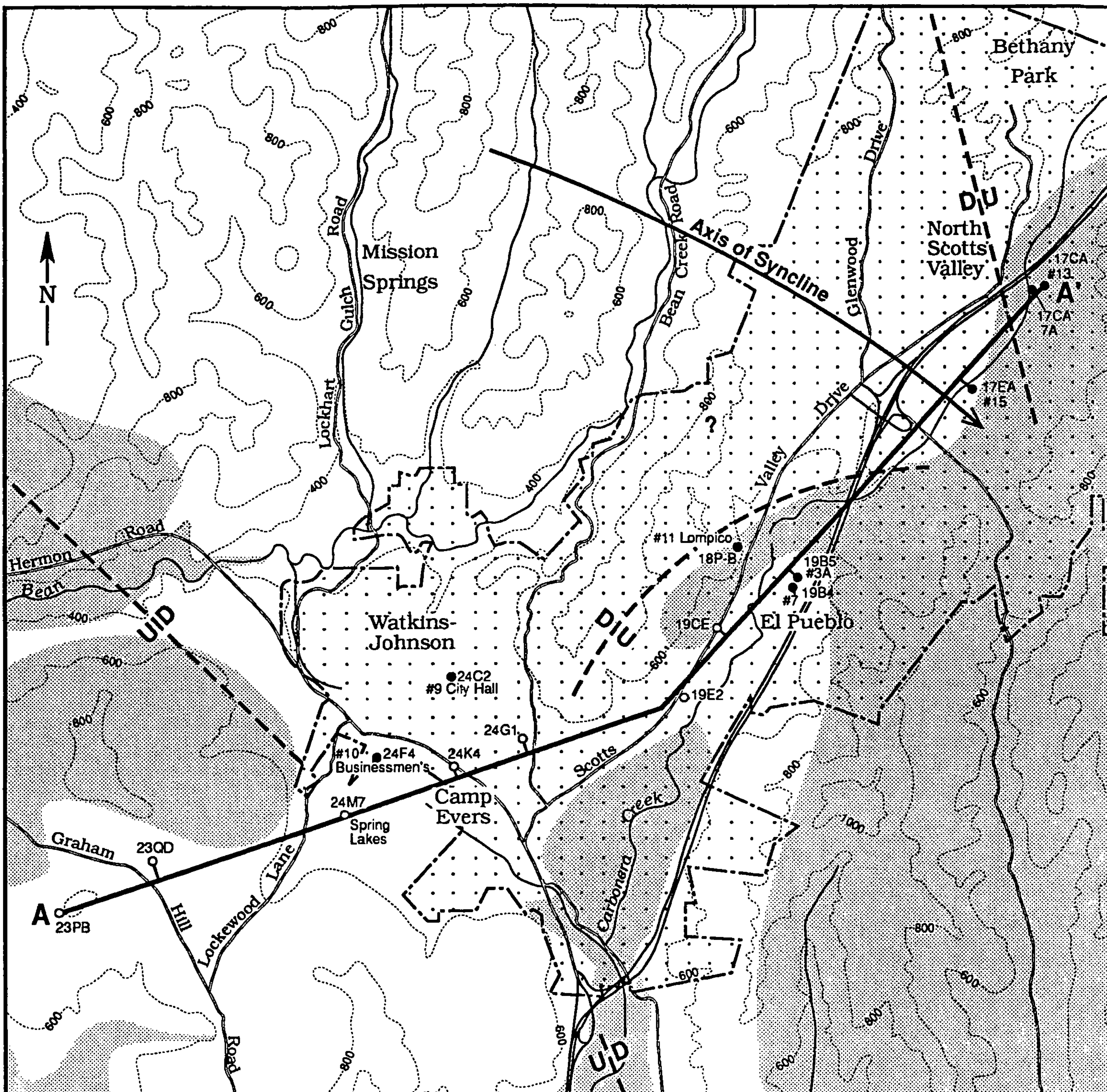

Legend

- ○ Well
- ● SVWD Production Well

SVWD Boundary

Unsaturated Santa Margarita Sandstone

Scale

0 2000 4000 feet

Figure 3
Cross Section A - A'
Location Map

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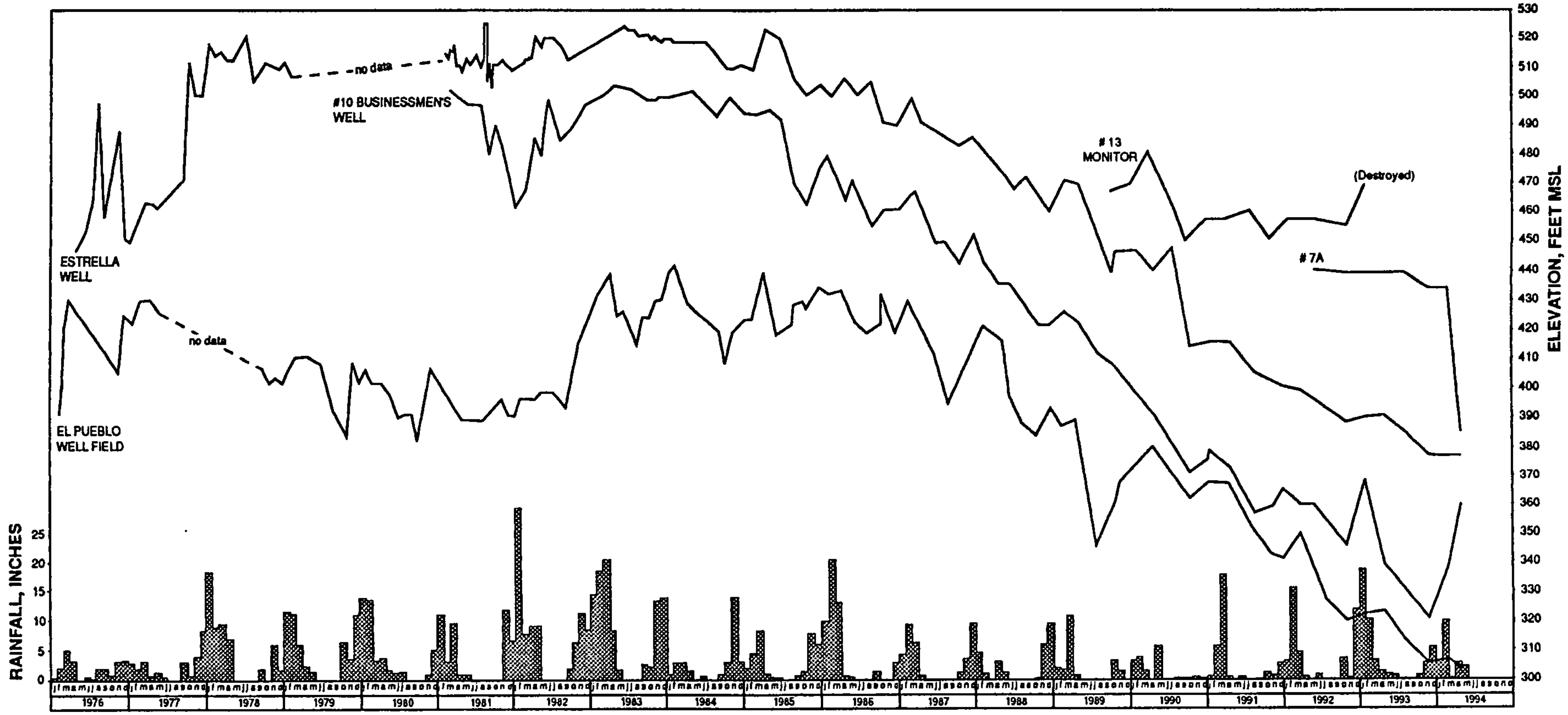

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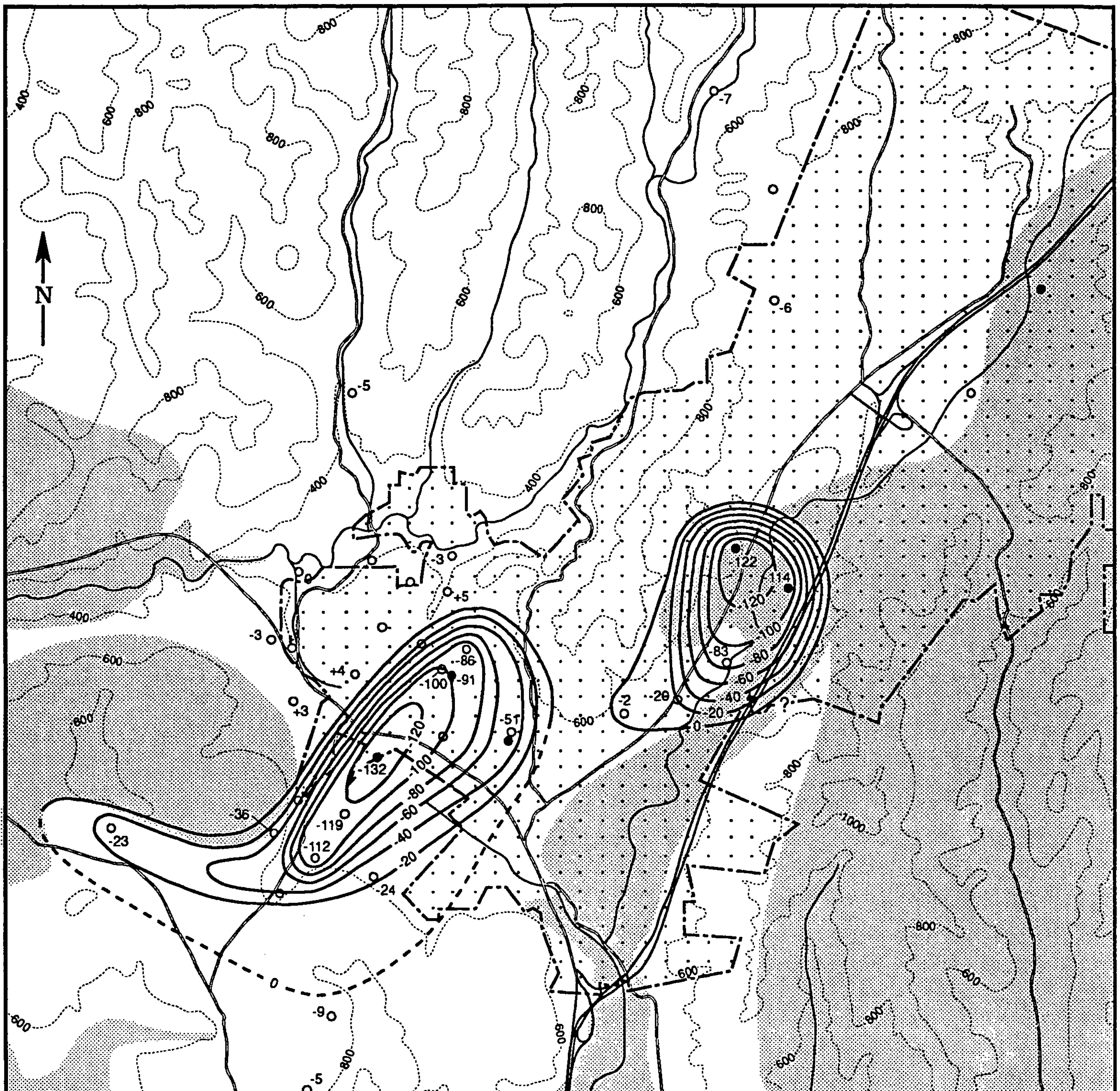
Figure 6
Water Level Trends in Selected Wells



Legend

- ○ Well
- ● SVWD Production Well
- -20— Contour in feet (change)

SVWD Boundary

Approximate Area of No Saturated Santa Margarita Sandstone

Scale

0 2000 4000 feet

Figure 7
Water Level Change
April 1986 - April 1993

June 1994

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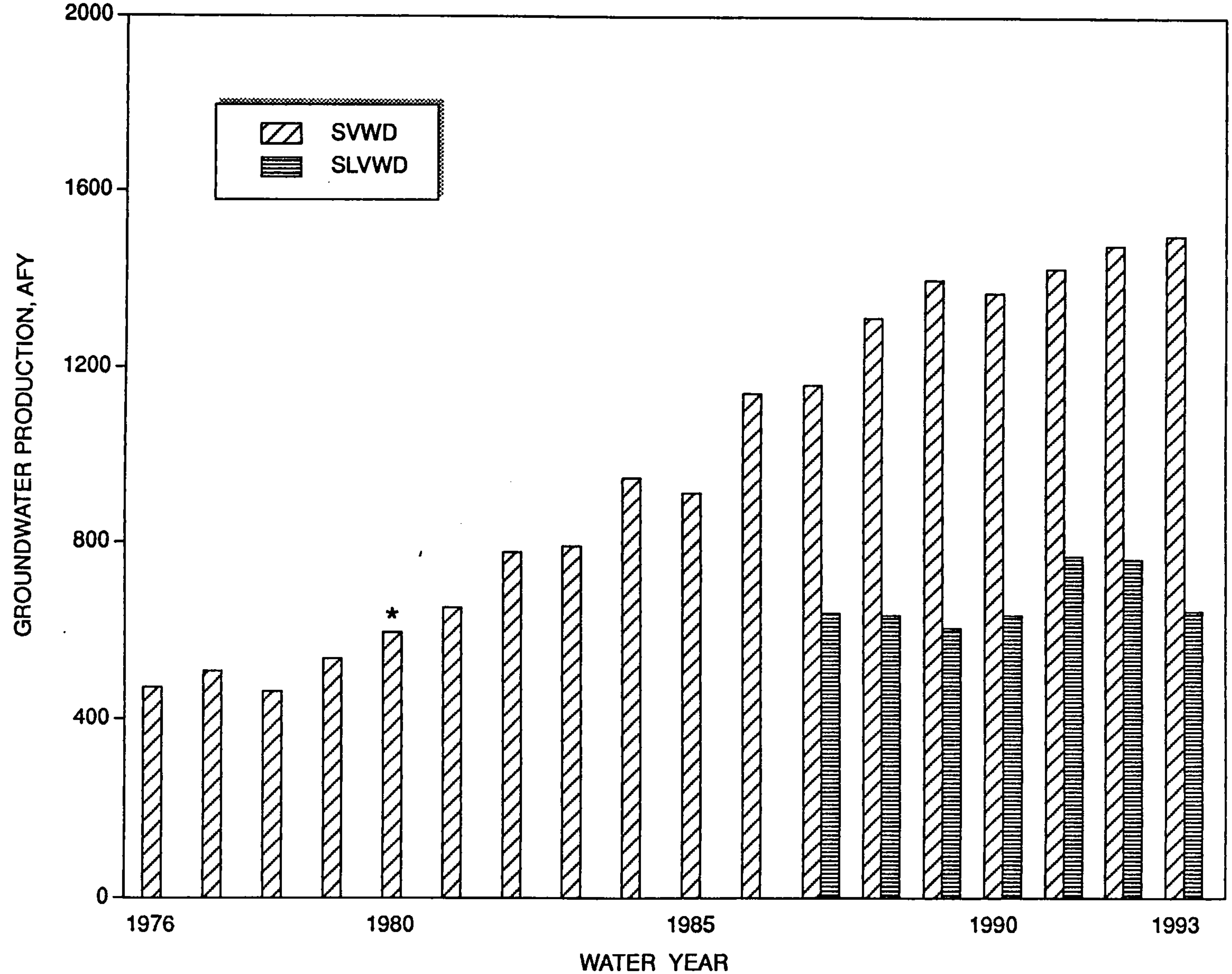
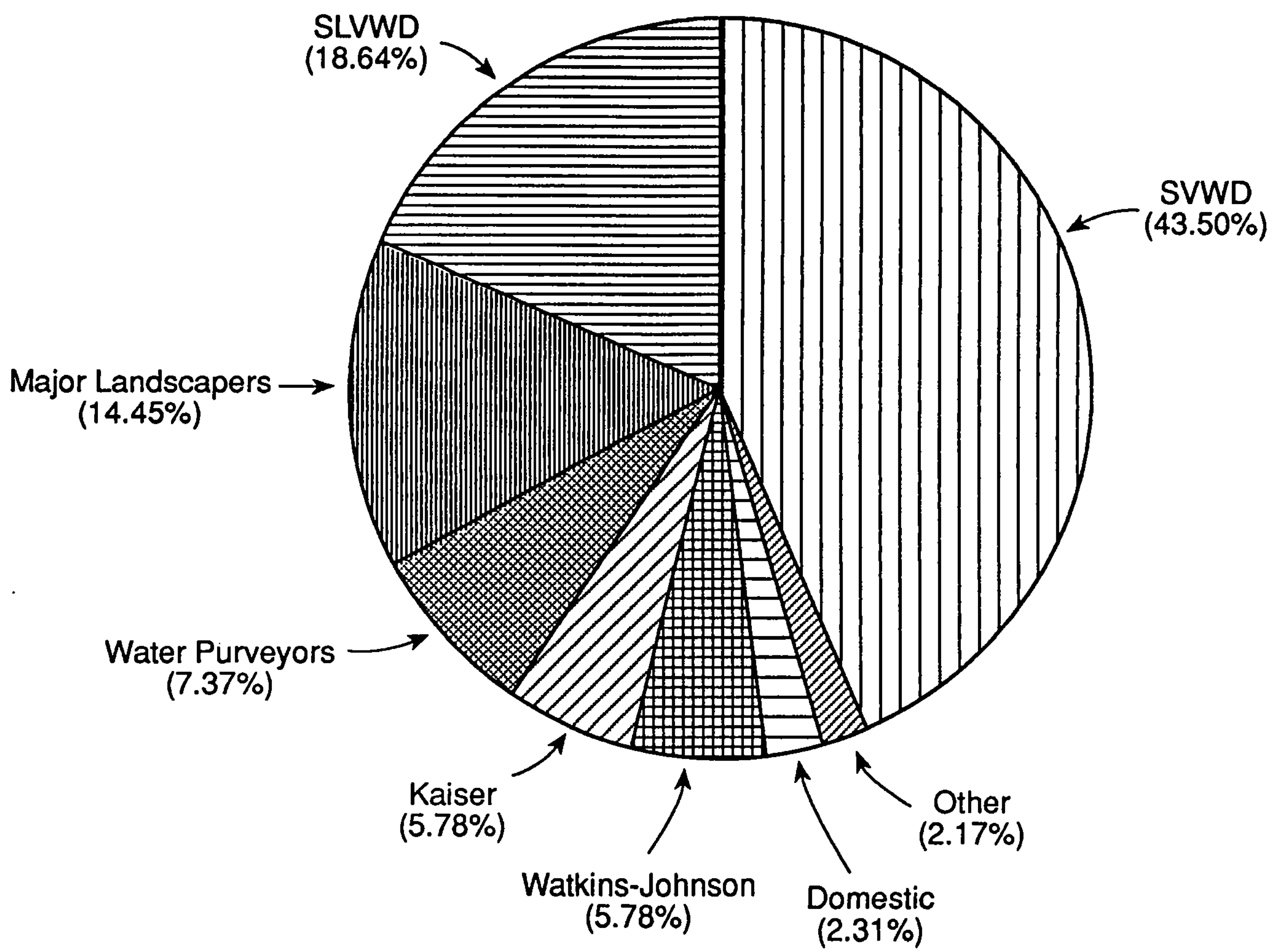


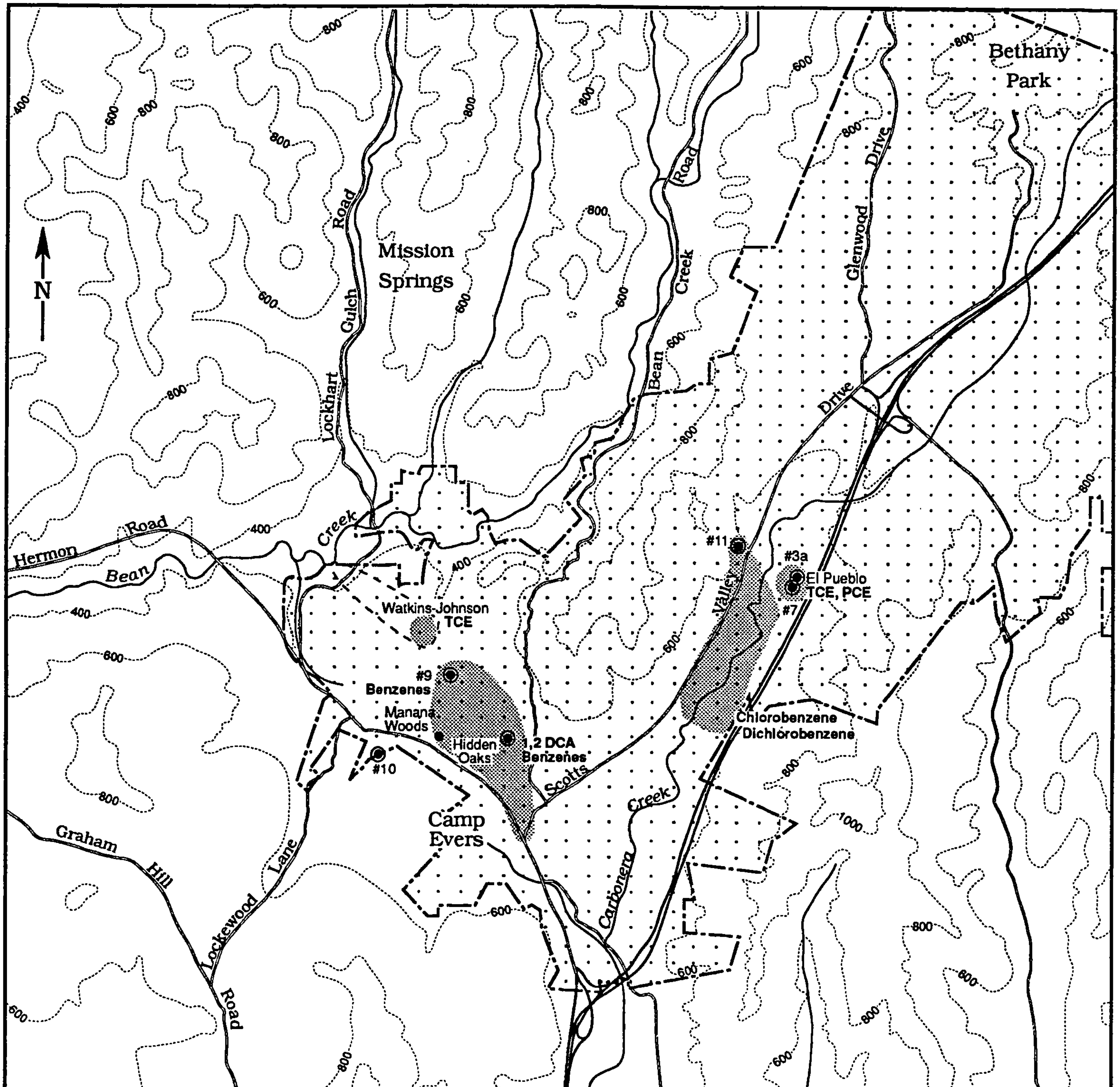
* Estimated

June 1994	Figure 8
DAVID KEITH TODD Consulting Engineers, Inc. Berkeley, California	**Groundwater Production** **SVWD 1976 - 1993 and** **SLVWD 1987 - 1993**



Estimated Total Pumpage: 3460 AFY

June 1994	**Figure 9**
DAVID KEITH TODD Consulting Engineers, Inc. Berkeley, California	**Current Distribution of Groundwater Production**



Legend

- SVWD Production Wells
- Approximate Plume Area
- Former Plume Area
- SVWD Boundary

Scale

0 2000 4000 feet

Figure 10

Groundwater Quality Problems

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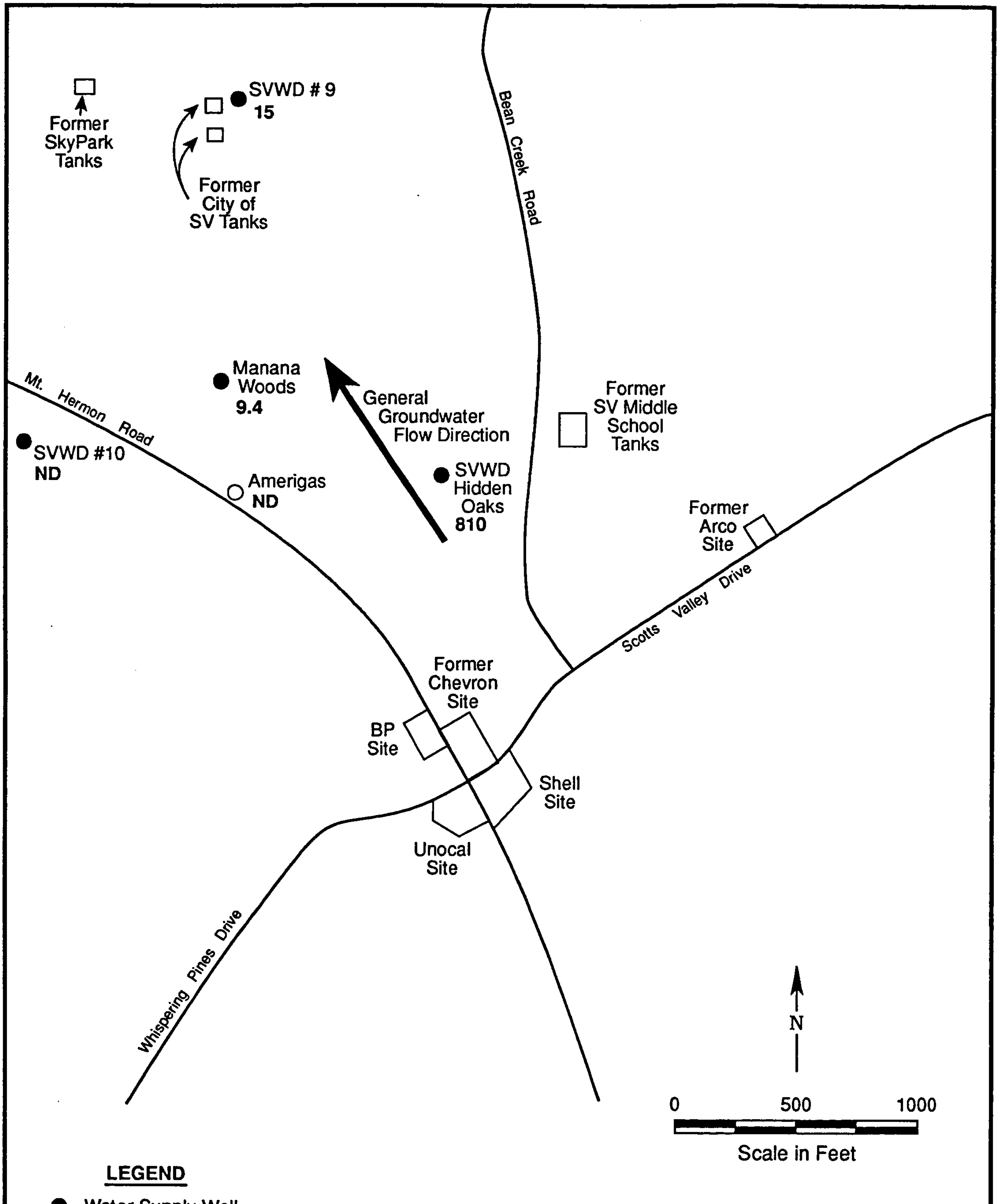

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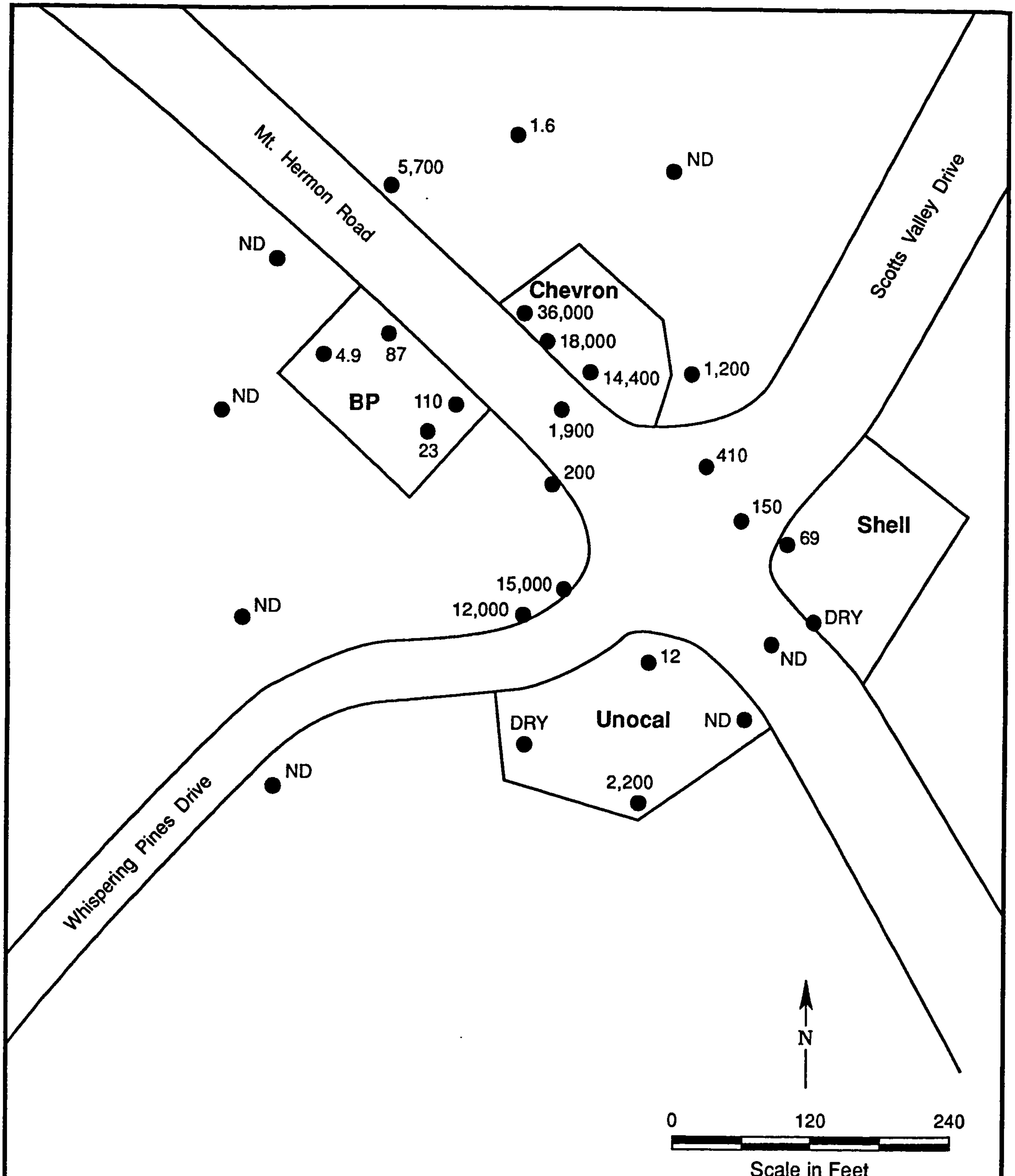
Figure 11
Possible Sources of Camp Evers Water Supply Well Contamination



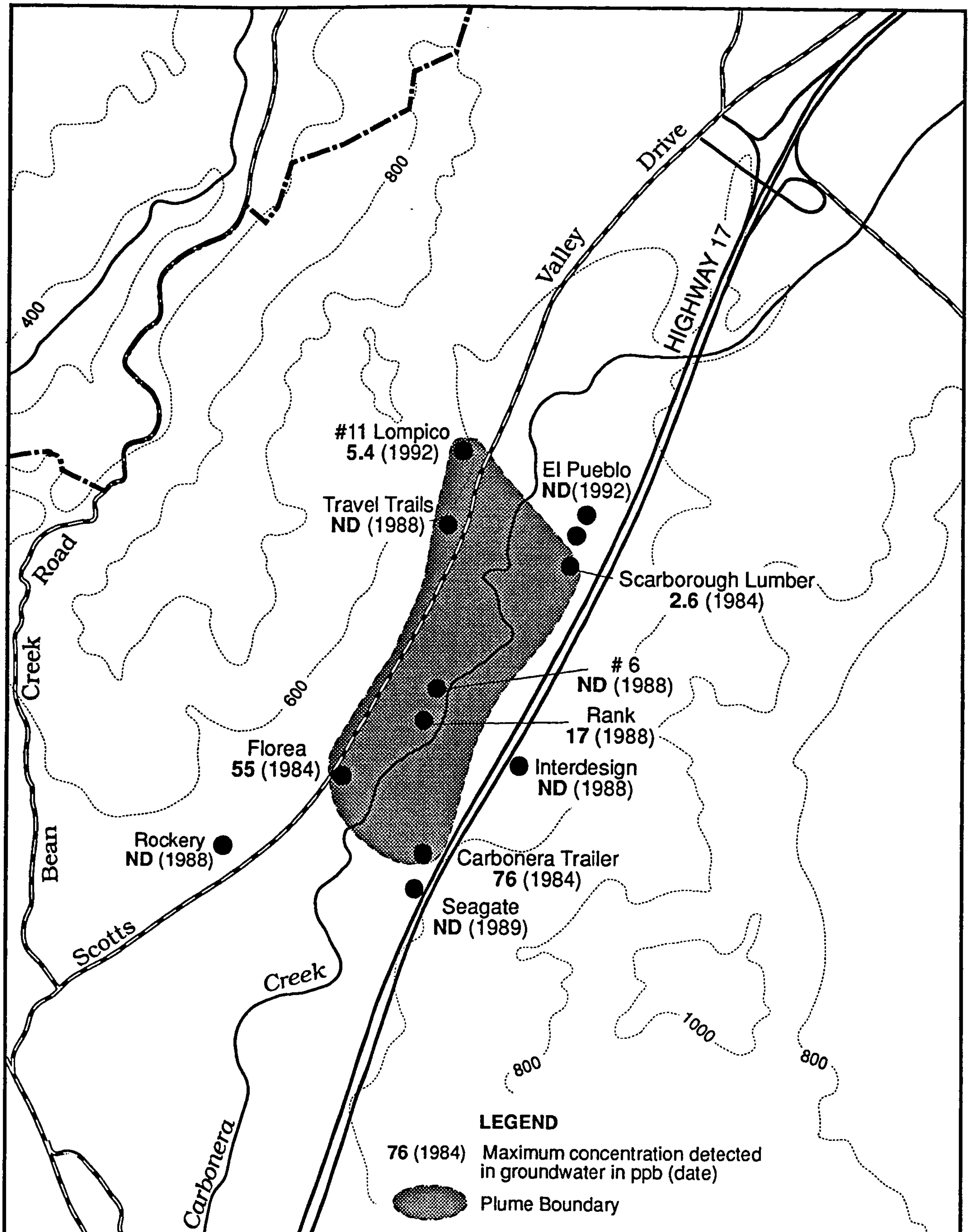
LEGEND

● Monitoring Well

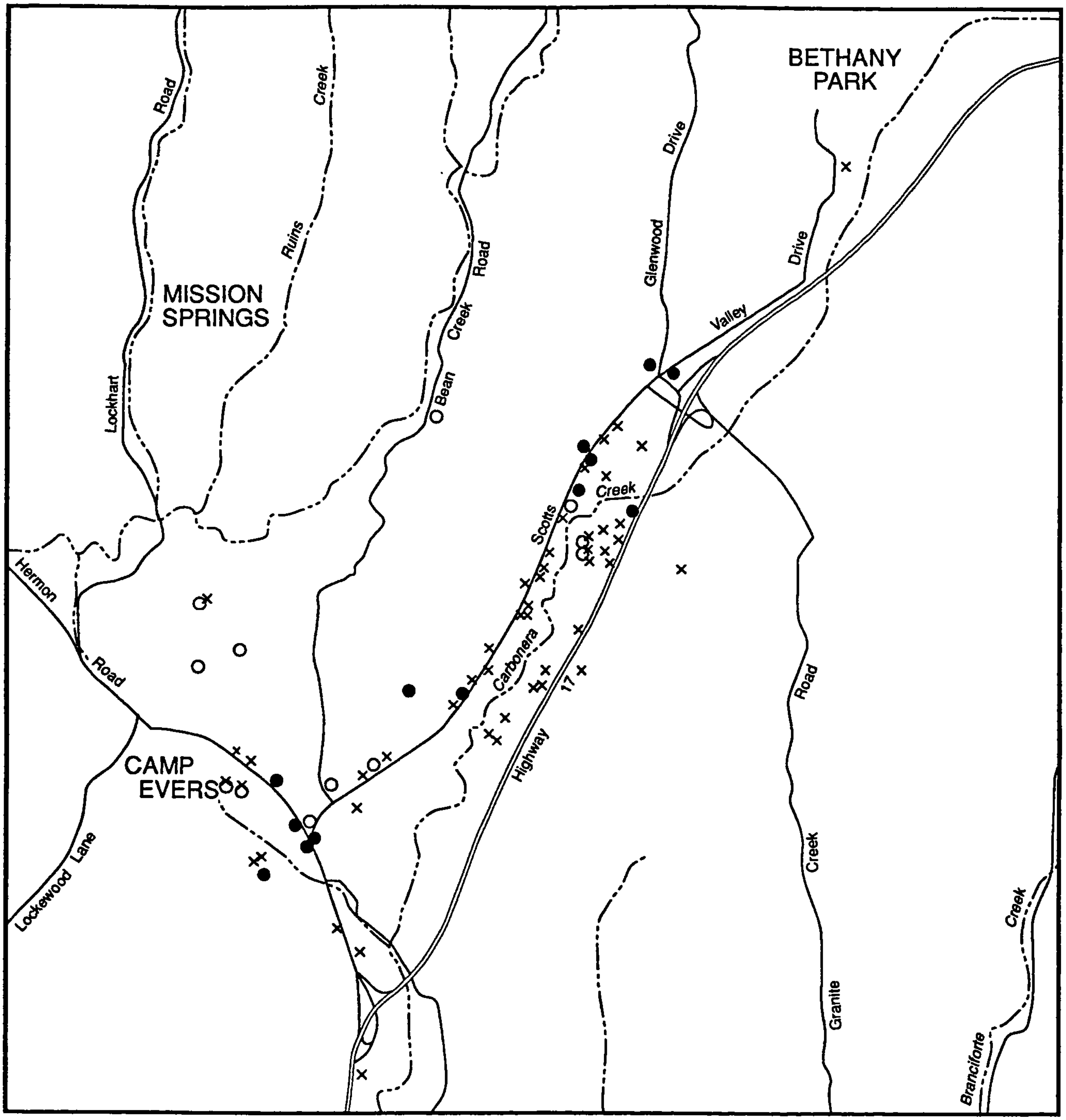
15 Highest Concentration of Benzene(ppb)

ND Not Detected

June 1994	**Figure 12**
DAVID KEITH TODD Consulting Engineers, Inc. Berkeley, California	**Possible Sources of Camp Evers Water Supply Well Contamination**



June 1994	Figure 13 Estimated Chlorobenzene Plume
DAVID KEITH TODD Consulting Engineers, Inc. Berkeley, California	



LEGEND

- ● Underground Storage Tanks, Active
- ○ Underground Storage Tanks, Inactive, Removed or Closed in Place
- × Hazardous Materials Use

N

0 2000
Scale in Feet

Figure 15
Underground Storage Tank and Hazardous Material Locations

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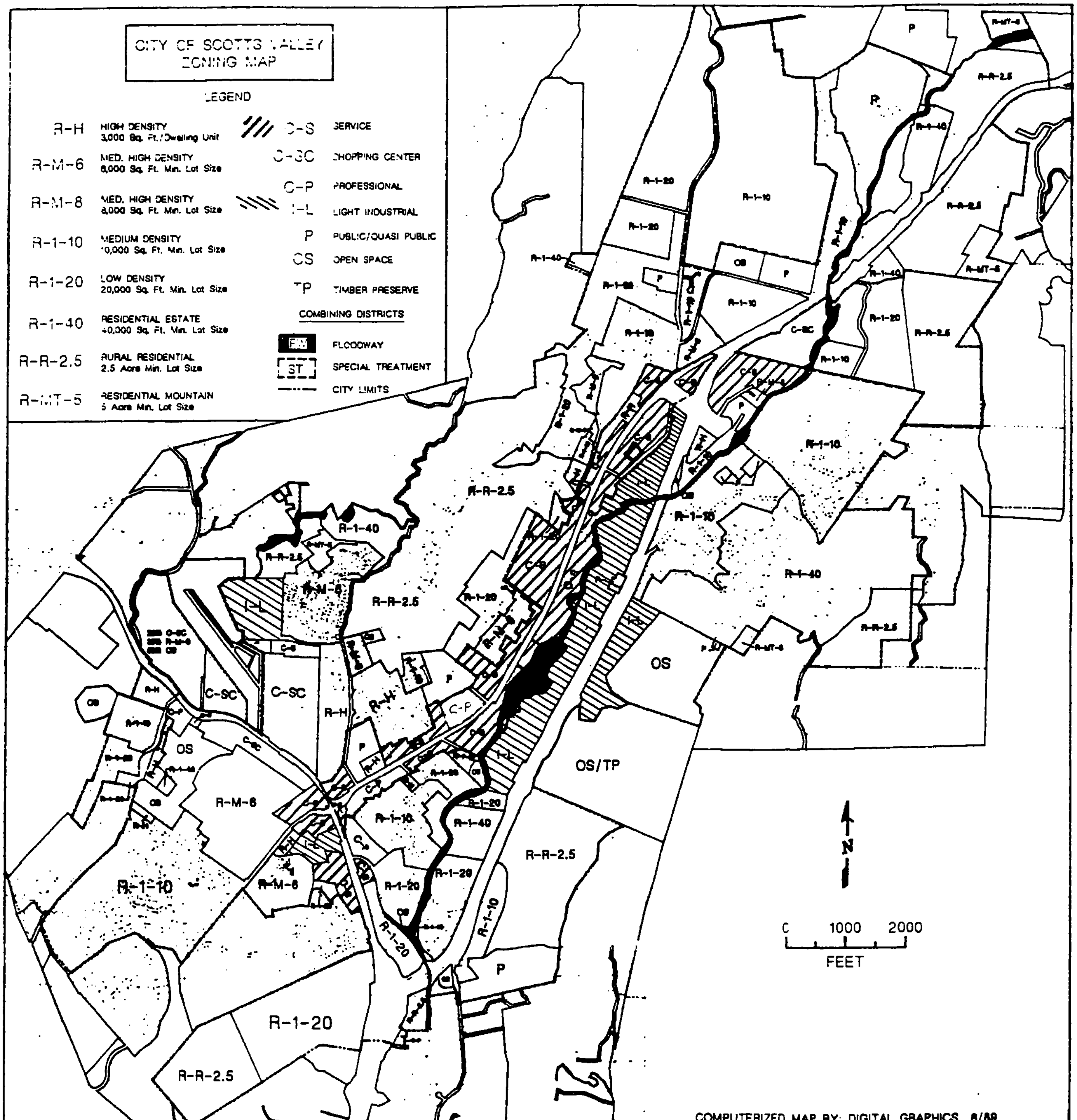

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Figure 17
City of Scotts Valley Zoning

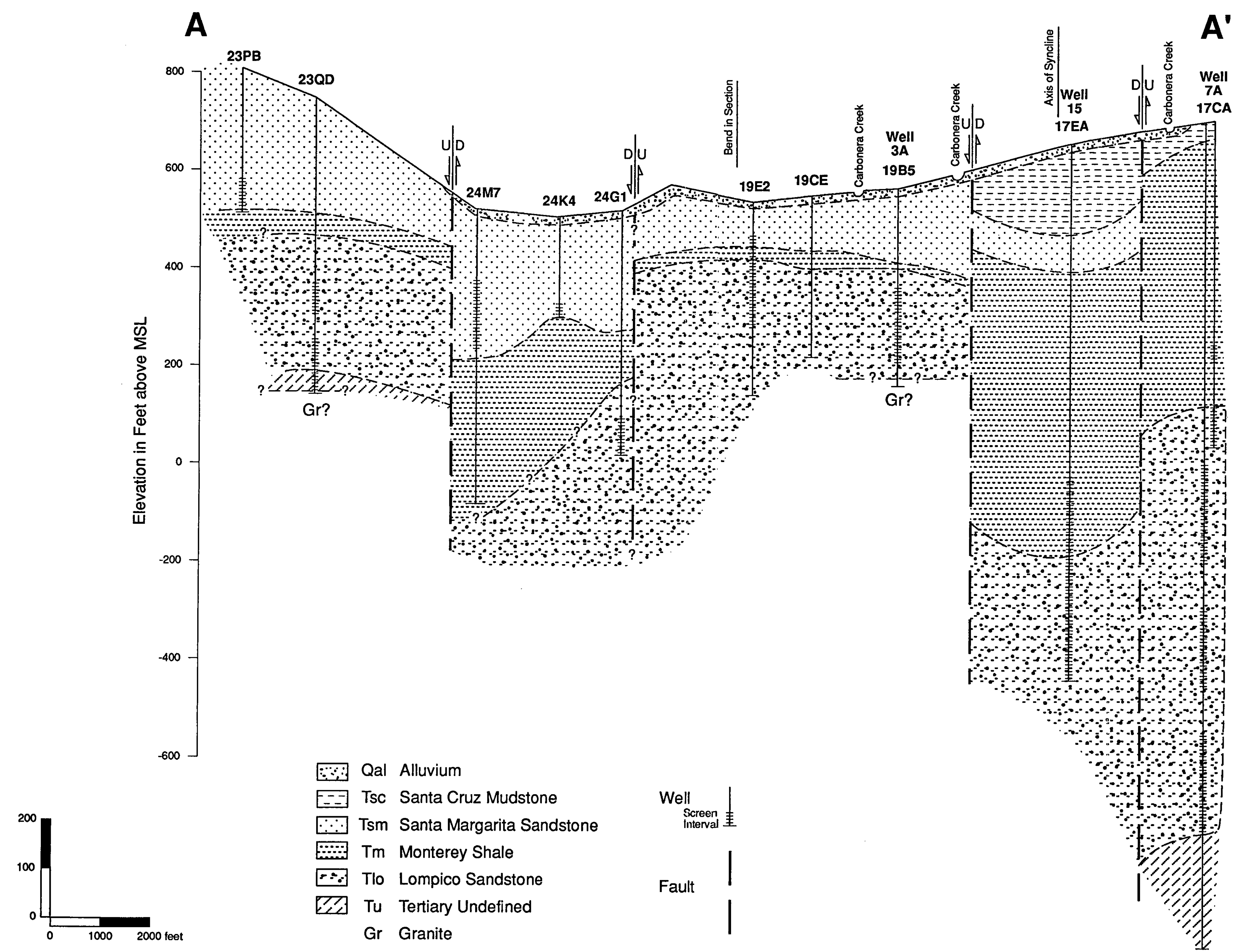

Figure 4
Cross Section
A - A'

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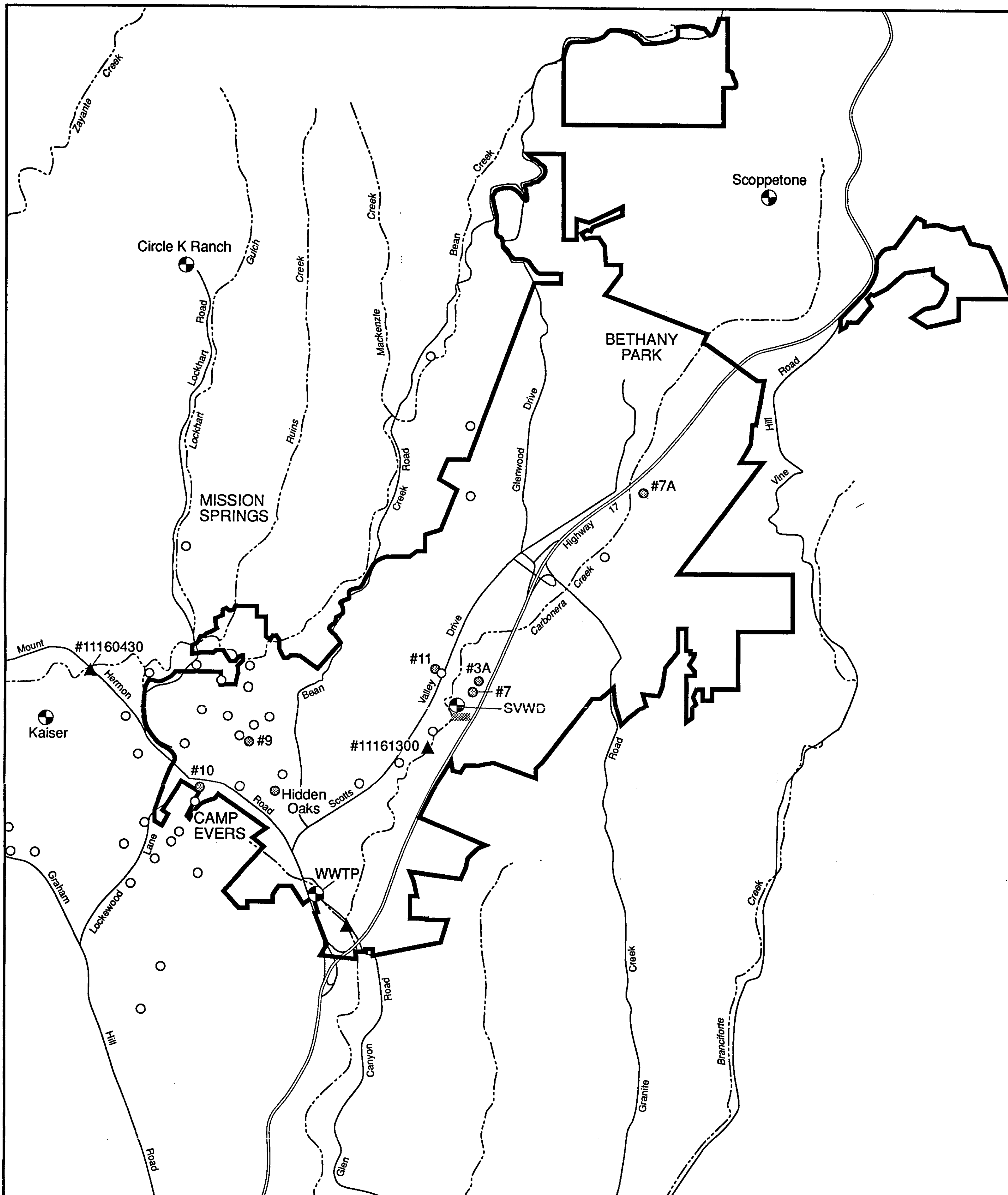

LEGEND

- Scotts Valley Water District Boundary
- Stream Gage
- Precipitation Gage
- Evaporation Gage
- Groundwater Level Well
- SVWD Production Well

N

0 2000
Scale in Feet

Figure 5
Monitoring Locations

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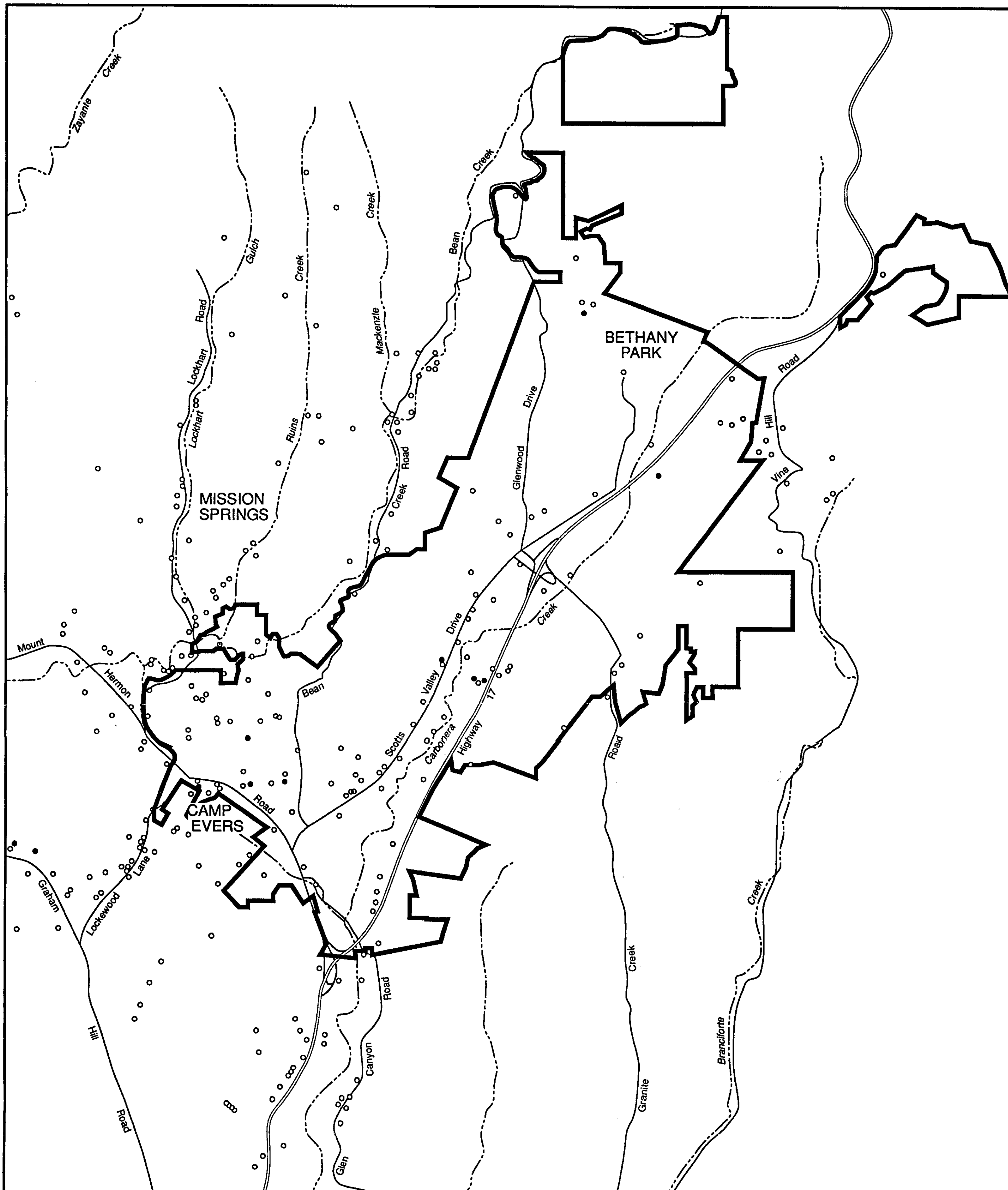

LEGEND

Scotts Valley Water District boundary

Private domestic, irrigation or industrial well

Municipal water supply well

N

0 2000

Scale in Feet

Figure 14
Water Well Locations in the Scotts Valley Area

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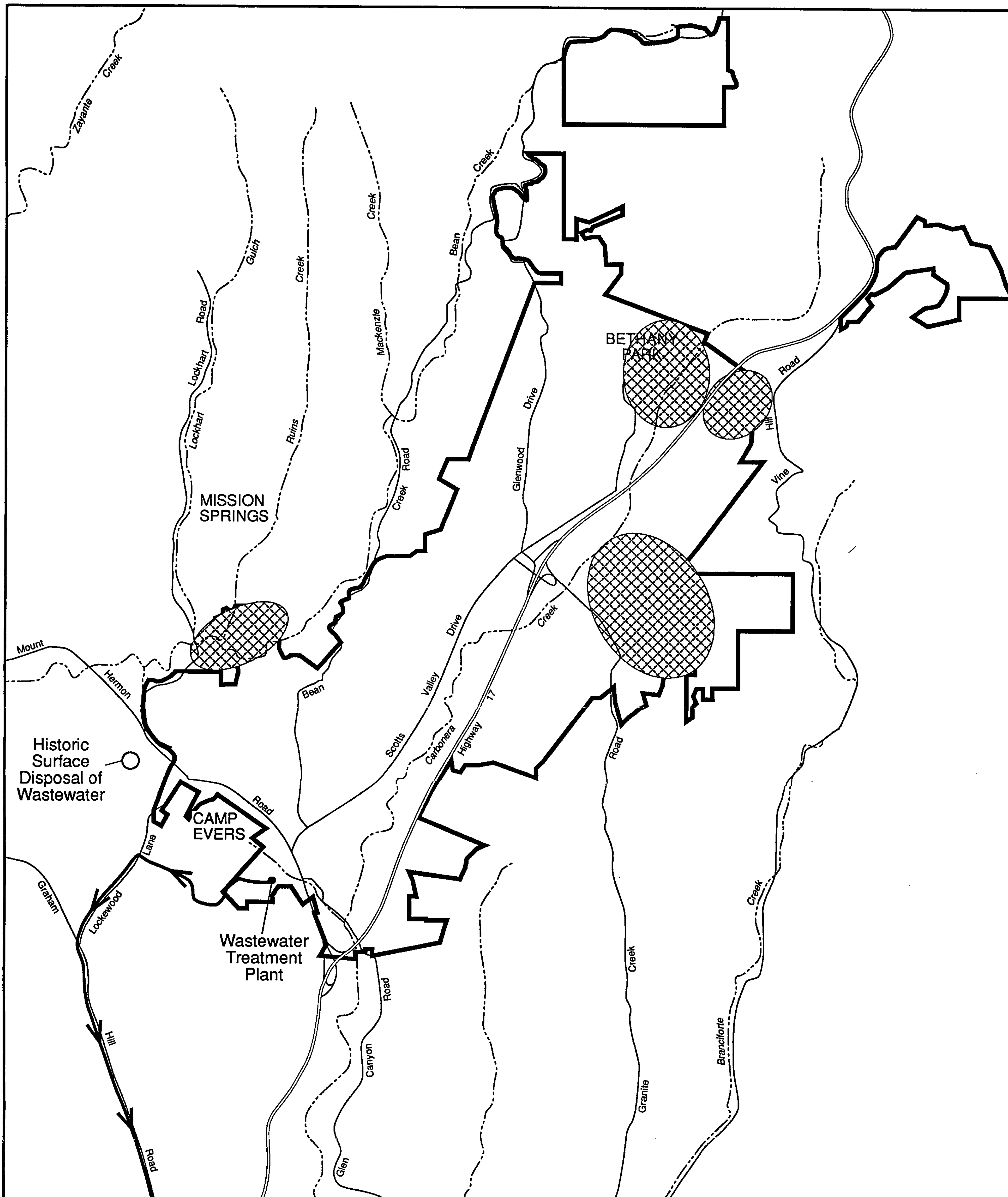

LEGEND

Scotts Valley Water District Boundary

Approximate Major Residential Areas on Septic Systems

Treated Wastewater Disposal to Ocean

N

0 2000

Scale in Feet

Figure 16
Wastewater Treatment and Disposal Facilities

June 1994

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